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MONOGRAPH III.

THE CROCODILIAN REMAINS FOUND IN THE ELGIN SANDSTONES,

WITH

REMARKS ON THE ICHNITES OF CUMMINGSTONE.

BY

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PREFACE.

IN the following Monograph Professor Huxley has given detailed descriptions of all that is yet known of the scutes, bones, and teeth of *Stagonolepis Robertsoni* of the Elgin Sandstones, which so much resemble the neighbouring Old Red Sandstone, that, not unnaturally, they were considered to be of that age.

The masterly work done by the Author in proving the crocodilian nature of Stagonolepis, taken in connexion with the discovery of Telerpeton and Stagonolepis in the same strata, very soon satisfied Geologists that the Elgin Sandstones must be considered as part of the Trias, and, most probably, to that part of the series known as the Lower Keuper Sandstone.

The importance of this revolution will be recognised by all persons competent to judge of the subject, whether from a palæontological or a purely geological point of view.

ANDREW C. RAMSAY,
Director General.

Jermyn Street,
August 4th, 1877.

THE

CROCODILIA OF THE ELGIN SANDSTONES.

I.—STAGONOLEPIS ROBERTSONI.

I.—Introductory Remarks upon the Discovery of Reptilian Remains in the Elgin Sandstones, and upon the Geological Age of those Sandstones.

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1. The Dermal Scutes.
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4. The Skull.
5. The Teeth.
6. The Bones of the Pectoral and Pelvic Arches and of the Limbs.

III.—The Taxonomy, or Systematic Position, of *Stagonolepis Robertsoni.*

I. Introductory Remarks upon the Discovery of Reptilian Remains in the Elgin Sandstones, and upon the Geological Age of those Sandstones.

At p. 139 of the late Professor Agassiz's celebrated "Poissons Fossiles du vieux Grès rouge," a passage occurs of which I give the following translation.

Genus *Stagonolepis*, Agass.

"I have established this genus upon a slab on which are observable the impressions of many series of great rhomboidal scales, disposed in the same manner as those of the *Lepidosteidæ.* The angular form of these impressions allows of no doubt that the fish whence they proceeded was a great Ganoid allied to *Megalichthys.* The absence of the fins, of the head, and of teeth, however, prevents the rigorous determination of the family to which this fossil belongs. I arrange it, provisionally, near the genus *Glyptopomus*, with which it has some analogy in the ornamentation of its scales. However, this genus *Stagonolepis* cannot be confounded with any of those which I have hitherto established. The surface of its scales is adorned with hollows, having the shape of elongated drops, disposed like a rosette around the centre of each scale; these hollows increase in size towards the periphery, without, however, reaching the margins, which are smooth. I know as yet but a single species of this genus, the *Stagonolepis Robertsoni*, Ag., Old Red., Tab. 31, figs. 13 and 14.

"Figure 13 represents the impression of four scales, of the natural size and in their normal position. Figure 14 is a drawing of the entire specimen which was observed by Mr. Robertson, reduced to one half of the natural size. This fossil was obtained from the upper beds of the Old Red Sandstone of Morayshire. It was discovered in the neighbourhood of Elgin, at Lossiemouth. I have not examined the original myself, but the drawings which Mr. Robertson has communicated to me, and which I have reproduced in the plates of my Atlas cited above, are sufficient to enable me to recognise the type of an entirely new genus. In the fossil in question, the ornaments of the scales are in relief; but it must not be forgotten that it is only an impression and that, consequently, the scales, in their natural state, must have their ornamentation hollow."

Considering that when Professor Agassiz wrote, the Devonian age of the Elgin Sandstones was generally accepted, and keeping in mind the singular resemblance in arrangement and ornamentation which really obtains between the exoskeleton of *Stagonolepis* and that of *Glyptopomus*, an undoubtedly Devonian fish, there is nothing to excite surprise either in his determination of the nature of the fossil, or in the fact that Agassiz's interpretation was adopted, without hesitation, by geologists and zoologists. The late Sir Charles Lyell, however, informed me that, many years ago, after perusing Dr. A. Wagner's Memoir on ***Mystriosaurus***, the strong resemblance between the sculpture of the dermal plates of *Stagonolepis* and that exhibited by the scales of ***Mystriosaurus***, as figured by Wagner, excited his suspicions as to whether, after all, *Stagonolepis* might not be a reptile. But, on communicating these doubts to the late Mr. Hugh Miller, that experienced investigator of the fishes of the Old Red Sandstone expressed himself so unhesitatingly in favour of the piscine nature of *Stagonolepis* that Sir Charles Lyell's scruples were satisfied, and it was not until the year 1858 that the question, whether *Stagonolepis* was really a fish, was revived.

In that year, however, the late Sir Roderick Murchison, the then Director General of the Geological Survey of the United Kingdom, was engaged in those remarkable investigations of the structure of the Highlands of Scotland which led to a complete change in the views which geologists had, up to that time, entertained on the subject.

In the course of his inquiries, Sir Roderick Murchison was led to visit Elgin and its neighbourhood, and to inspect the fossils of the district contained in the Elgin Museum and in the private collections of the late Mr. Patrick Duff and the Reverend Dr. George Gordon. Among these was the original specimen of *Stagonolepis Robertsoni* (Plate I., fig. 1), a cast in sandstone of the ornamented dermal plates of an animal which Agassiz had every reason to think might be a fish, and of which, it must be recollected, he saw only a drawing transmitted to him by Dr. Robertson. But, subsequently to the publication of Agassiz's observations upon *Stagonolepis*, additional specimens had been obtained, in which, associated with the *Stagonolepis* scutes in such a manner that there could be no doubt that they belonged to the same animal, were fragments or casts of bones of so obviously reptilian a character as to awaken grave doubts in the mind of their discoverer, the Rev. Dr. Gordon, as to the nature of the supposed fish, and to lead him to believe that *Stagonolepis* must be an animal of higher organization.

Apart from the interest of the purely zoological question thus raised, the existence of any vertebrated animal of higher grade than a fish in the sandstones of Findrassie and Lossiemouth was a fact of great geological importance. The Elgin district had yielded a small quadrupedal vertebrated animal, the *Telerpeton Elginense* of Mantell (the amphibian or reptilian nature of which was still a matter of dispute), and, in addition, many footmarks of very much larger quadrupedal *Vertebrata.* So that there was nothing unexpected in the discovery of the actual bones and scutes of such animals. But the discussion respecting the age of the Elgin sandstones, which had been awakened by the discovery of the footprints and of *Telerpeton,* had ended in the general admission that they belonged to the Devonian epoch; and this conclusion was confirmed by Sir R. Murchison's renewed study of the district.

It appeared, therefore, that the remains of *Stagonolepis* were calculated to throw a new light upon the vertebrate Fauna of the Devonian epoch; and Sir R. Murchison used every effort to bring together all the materials which could be of service. In these efforts Sir Roderick Murchison was aided in the most zealous and liberal manner by the committee of management of the Elgin Museum, by the late Mr. Patrick Duff, and by the Rev. Dr. Gordon.

One or two of the fossils thus obtained were exhibited by Sir Roderick Murchison at the meeting of the British Association at Leeds in 1858, but no person who examined them expressed a more definite opinion than that at which Sir Roderick himself had arrived, namely, that they were reptilian in their general character. On his return to London in the autumn of 1858, the Director General informed me of what he had seen at Elgin, and told me that Sir Philip Egerton and Professor Owen, who had cursorily examined the fossils exhibited at Leeds, had as little doubt respecting their reptilian nature as himself. But no one had expressed any opinion as to the group of reptiles to which *Stagonolepis* belonged, and Sir Roderick desired that I should undertake the investigation of the problem. To this end the fossils which had been exhibited at Leeds were placed at my disposal; while the larger and more important series which had remained at Elgin were sent direct to me. It was on these materials that I based the conclusion that *Stagonolepis* is a crocodilian reptile; a fact of which Sir R. Murchison had no suspicion when he placed the inquiry in my hands, and the announcement of which caused him the liveliest surprise, believing as he did that the Elgin beds were of Devonian age. Moreover, I found that all the Elgin fossils did not belong to the same genus; but that, in addition to *Telerpeton,* there was at least one other reptile, which I named *Hyperodapedon Gordoni.**

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* See my paper " On the *Stagonolepis Robertsoni* (Agassiz) of the Elgin Sandstones, and on the recently discovered Footmarks in the Sandstones of Cummingstone," read before the Geological Society, December 15th, 1858.

In 1859, I had the opportunity of examining the collection of Dr. Taylor, and the series of Elgin fossils contained in the Museum of Aberdeen. And, since that time, the Rev. Dr. Gordon, to whose help I am very greatly indebted, has kept me informed of all the discoveries of fossils in the quarries of the neighbourhood which have come to his knowledge; and, aided by a grant from the donation fund of the Royal Society, has made explorations which have yielded most valuable results. Mr. Grant, of the Schoolhouse, Lossiemouth, has further helped by the loan of specimens, and I have thus been enabled to add from time to time to what was known respecting *Hyperodapedon* and *Telerpeton.** But it is a singular fact that, in the course of the nineteen years during which the produce of the quarries about Elgin has been carefully scrutinized, the only remains which have been discovered are those of *Stagonolepis, Hyperodapedon, Telerpeton,* and the jaw with large teeth described in my first paper, and which I then ascribed to *Stagonolepis;* though the subsequent discovery of the true teeth of *Stagonolepis* enables me to correct that error.

In the brief notice of *Hyperodapedon,* appended to my paper of 1858, I said that "its marked affinity with certain Triassic "reptiles, when taken together with the resemblance of "*Stagonolepis* to Mesozoic *Crocodilia,* leads me to require the "strongest stratigraphical proof before admitting the Palæozoic "age of the beds in which it occurs." And Sir R. Murchison, even then, admitted that his belief in the Devonian age of the Elgin sandstones was somewhat shaken by the discovery of the true nature and affinities of these reptilian remains.

In fact, this discovery led to a re-investigation of the age of the Elgin sandstones by several eminent geologists, among others, the late Sir Charles Lyell, with the result that opinions and weight of authority were about equally divided; Murchison, Ramsay, Harkness, and others, being inclined still to regard them as Palæozoic, while Lyell and Moore advocated the view that they were Triassic.

In the years 1866, 1867, and 1868, however, some remarkable facts came to light, which brought the question into a new phase. Remains of *Hyperodapedon* were proved to occur in the unquestionable Trias of Coton-End in Warwickshire, and in beds of Triassic age in Devonshire; while, in Central India, jaws of a large species of *Hyperodapedon* were found, in association with Labyrinthodonts and *Crocodilia,* at Maledi, in beds to which, on independent grounds, a Triassic or Permian age had been assigned.†

In view of these facts, Sir Roderick Murchison remarks at p. 267 of the fourth edition of "Siluria" published in 1867:

"To such fossil evidence as this the field geologist must bow; and instead, therefore, of any longer connecting these reptiliferous sandstones of Elgin and Ross with the Old Red Sandstones beneath them, I willingly adopt the view established by such fossil evidence, and consider that these overlying sandstones and limestones are of Upper Triassic age."

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* "On a new specimen of *Telerpeton Elginense,*" "Quarterly Journal of the Geological Society," 1866.

† "On *Hyperodapedon,*" "Quarterly Journal of the Geological Society," 1869.

II. DESCRIPTION OF THE REMAINS OF STAGONOLEPIS ROBERTSONI. (Plates I. to VIII.)

The fossils, which may be safely referred to *Stagonolepis Robertsoni*, which have come into my hands, afford a tolerably complete view of the whole bony structure of the animal, and consist of—

1. Dermal scutes.
2. Vertebræ from all parts of the vertebral column and ribs.
3. Portions of the skull with teeth.
4. Bones belonging to the pectoral and pelvic arches, and to the respective limbs.

In the soft sandstones of Lossiemouth, the actual substance of the bones and teeth is preserved, though in an exceedingly soft and friable state. In the more firmly grained and harder sandstones of Findrassie, on the other hand, nothing but casts remain, though these are sometimes so perfect as to retain the outward form of their originals with great fidelity.

Portions of at fewest three, and probably of many more, individuals have been met with. In the largest of these, the bones were about twice the size of those of a *Crocodilus biporcatus*, 7 feet long, whence I conclude that this *Stagonolepis* measured 12 or 14 feet in length. The smallest had about two-thirds of the dimensions of the largest.

1. *The Dermal Scutes of Stagonolepis Robertsoni.* (Plates I., II., III., IV.)

The remains referable to this part of the organization of *Stagonolepis* consist of stout broad plates of bone, or their casts. These scutes are primarily distinguishable into two kinds, the *flat* and the *angulated;* the former being distinguished by their flattened inner and outer surfaces, and their nearly square shape; while the latter present a more or less elevated longitudinal ridge on their outer surface, to which an excavation of the inner surface corresponds.

The flat Scutes of Stagonolepis.—The sandstone cast upon which the genus *Stagonolepis* was originally founded exhibits a very characteristic impression of a considerable number of these scutes with their natural relations almost undisturbed. The sculptured portion of this specimen is represented of the natural size in Plate I., fig. 1, and a reproduction of the sculpture on the outer surface of two of the original scutes, effected by taking a plaster-cast from it, is given in fig. 1a of the same Plate.

The specimen is an irregularly broken mass of sandstone, the convexo-concave face of which exhibits numerous impressions of four-sided scutes. Of these there are, altogether, five rows in one direction and eleven, with a fragment of a twelfth, in the other. A plaster-cast shows, even better than the original, that, while one opposed pair, out of the four edges of each scute, fitted against the adjoining edges of the scutes on each side, the other pair of edges alternately overlapped, and were overlapped by, those of the adjacent scutes. There can be no doubt that the overlapped edges were anterior, and, as I shall presently show that these scutes formed part of the ventral armour of the animal to which they belonged, the direction and relations of each row become at once definable. The five rows are longitudinal—the eleven transverse. None of these rows are complete. The left-hand longitudinal row contains five scutes, whose outer edges are more or less broken away. The next row contains seven scutes, the posterior of which are somewhat thrust forward, and their left edges somewhat broken. The third row contains eight scutes and the right sides of the anterior four are defective. Each of these longitudinal rows extends to the same level anteriorly; but the next, or fourth, series begins opposite the fifth scute of the third series, and but a very small portion of its most anterior scute is visible. This is followed by six scutes, of which the hindermost are somewhat displaced and thrown forwards one upon the other. The fifth series contains only the impressions of the halves of five scutes. The impression of an additional small fragment of a scute is visible in front of the first and third series.

Each scute is on exactly the same level as its right-hand and left-hand neighbour, so that the structure of the whole fragment is extremely regular. About a fifth of the outer surface of each scute is covered by the posterior edge of its predecessor; and the fifth and sixth scutes of the fourth series are sufficiently displaced to show that the covered surface was smooth and bevelled off obliquely, and thus constituted a sort of articular facet, narrow and parallel-sided antero-posteriorly, but very wide transversely.

The posterior edge of this facet is cut perpendicularly to the plane of the scute, from the face of which it rises like a kind of parapet. The face of the scute was ornamented with a peculiar sculpture, consisting of distinct deep pits. The casts of these are of course elevated, and lie like drops upon the general surface of the impression—an appearance which doubtless suggested the name of the genus. Near the centre of the face of the scute, the pits are nearly circular in outline, but, towards the periphery, they elongate in the direction of radii from a point rather nearer the anterior than the posterior edge of the whole scute, and assume a pyriform shape, the small end of each being directed inwards. The consequence of this arrangement is a very marked radiation of the ornamentation from a centre which lies about the junction of the anterior two fifths with the posterior three fifths of the whole ornamented surface. A small marginal space, laterally and posteriorly, is, as Agassiz has observed, free from sculpture.

An inch and a quarter transversely, by a little less antero-posteriorly, is a fair statement of the average dimensions of these flat scutes.

Very many examples of the actual scutes, of which the fossil just described presents only the impressions, have been discovered in the Lossiemouth sandstones. A specimen in the collection of Dr. Taylor of Elgin exhibits five longitudinal series of flat scutes, but very little disturbed from their natural relations. The most complete of these longitudinal series contained eight scutes and occupied a length of about 7 inches. They gradually increase in size from one end of the series to the other, the smallest being rather less than 1·0 inch square, and the largest 1·0 inch long by 1·4 inch wide.

Two of the most perfect of these scutes are represented of the natural size in Plate I., fig. 2.

Each exhibits, along the whole width of its anterior side, a smooth facet, obliquely bevelled off to the free edge and measuring about 0·2 inch in its narrow or antero-posterior diameter. Behind this articular facet, is a well-marked, but shallow, transverse groove which separates the smooth facet from the sculptured portion of the scute. The sculpturing consists of shallow rounded or elongated pits, which radiate from a common centre; it is, in fact, the exact converse of the sculpturing in the cast. In some parts of the cast, the facet on a scute is still overlapped by the free posterior edge of the scute in front, and the direction of the articular facets shows that the narrow end of each longitudinal series was the anterior, the broad end posterior. Traces of what appear to be ribs are visible amongst the impressions of the scutes at one end of the fossil; and, on the opposite or under side of the block to that which shows the flat scutes which have been described, there are many, much crushed, flat scutes having their faces turned in the same way as those of the upper side. Sections of scattered dorsal scutes are visible in the thickness of the block.

The most complete set of flat scutes, however, is presented by a slab of Lossiemouth sandstone in the Museum of Aberdeen University, which shows the remains of seven longitudinal rows of such scutes. The smooth deep surfaces of all these are turned to the eye, but, on clearing away the osseous substance of one, the characteristic sculpture of the exterior appeared in relief on the matrix. There are indications of ten transverse rows of scutes. Four scutes in each row are of equal sizes, and, in all but the hindermost rows, are of a rectangular quadrilateral figure; they measure 1·4 inch anteposteriorly and 2·1 inches transversely. The scutes in the hindermost rows have their angles rounded off and are small, but it is difficult to ascertain their exact dimensions: On the left side two scutes lie, in each transverse row, at one end of the series of four rectangular ones. The inner of these is nearly as large as one of the latter, but not quite so wide, and its outer margin is either oblique or rounded; the outermost scute, although it has the same length as the inner, is much narrower, and its representative appears to have been wanting in the hindermost two or three rows. On the right side the remains of only a few of the scutes which answer to the inner of these smaller scutes are present.

The relative sizes and the arrangement of the scutes in these specimens lead me to conclude that there were six principal flat scutes in each transverse series; but that, in some rows, a smaller and less regular scute was added upon each side, making eight in all.

On comparing these scutes with those which constitute the ventral armour of a *Teleosaurus* (Plate XI.), or of an existing *Jacare* (Plate I., fig. 3), or *Caiman* (Plate XIII.), there can be no doubt as to their being structures of the same order.

But, apart from the general grounds for arriving at this determination, there is direct evidence that the flat scutes were disposed upon the ventral region of the body of *Stagonolepis*. Such evidence is afforded by one of the most singular fossils which has ever come under my notice, and which is, in fact, the natural cast, in sandstone, of the anterior caudal scutes and vertebræ of a *Stagonolepis*, but little disturbed from their natural position. This fossil, which is represented of three-fifths the natural size in Plate III., figs. 1, 1a, 1b, was discovered by Mr. Patrick Duff, who caused it to be sawn through longitudinally. A view of the cut face of one half is exhibited in Plate III., fig. 1c, and it is at once seen to exhibit a series of hourglass-shaped cavities, separated from one another by sandstone partitions, and to be traversed above two of these cavities by bars of sandstone attached at each end to these sandstone partitions, but quite free at the sides, and thicker in the middle than at each end. It was at once obvious that the hourglass-shaped cavities in question were the impressions of the centres, while the sandstone bars were the casts of the neural canals of vertebræ; but, in order to study the characters of these vertebræ more conveniently, I caused casts to be taken of the different parts of the fossil,* and these reproductions of the original specimen are represented in Plate III., fig. 2, and Plate IV., figs. 3 and 4. Plate IV., fig. 4, is a cast of the interior of the left half of the fossil, or that represented in Plate III., fig. 1c. Plate III., Fig. 2, represents a cast of the interior of the right half, and Plate IV., fig. 3, a cast of the surface of the fossil represented in Plate III., fig. 1.†

I shall have to revert to the peculiarities of the vertebræ reproduced in these casts at a future page; at present I merely wish to point out that they are obviously very little disturbed from their natural position, the majority of them being still articulated together, and their form and size being such that it is impossible they should have become exactly reversed within the dermal plates without dislocation. But if the vertebræ are not thrown out of their natural position, it follows that the dermal plates, the casts of which lie immediately under their centra, were ventral scutes.

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* These were made with great skill by Mr. Brucciani.

† The drawings have not been reversed by the artist.

Now these casts show (Plate IV., fig. 3) that the scutes in question were flat quadrilateral bony plates, with nearly straight edges, quite smooth upon their internal or upper faces, and sculptured, like those already described, upon their external or under faces.

The largest of these scutes has left an impression about 2·4 inches wide by nearly 2 inches long. The entire width of the fossil, at this point, is a little more than 4½ inches; hence, the ventral surface of the tail must have been covered by not more than two scutes.

Immediately behind this part, the fossil suddenly narrows, and at the same time, the cast shows that this results from the displacement of one series of ventral scutes which, having at first been driven inwards, have then been thrown into a perpendicular position, the scutes of the other series remaining nearly horizontal. As these measure fully 2 inches in width and about 1·7 inch antero-posteriorly, and as there must have been at least two scutes in a transverse row, it follows that the apparent sudden narrowing of the tail simply arises from postmortem distortion; and that it must, in reality, have tapered to but a very slight extent in the length of 10 inches, which is the longitudinal dimension of the specimen.

Altogether the casts of six transverse rows of ventral scutes appear.

The dorsal face of the specimen differs widely from the ventral. It is, in fact, strongly convex; so that, in transverse section, the fossil would have the contour of a high arched window, the ventral scutes representing the sill, and the dorsal, the arch of the window. Strong transverse ridges mark this aspect of the fossil and divide it into eight segments, of which the first and the last are very short. Each of the segments corresponds with the inner face of a large dermal plate, and every plate must have been so bent upon itself that its internal face was strongly concave from side to side, and slightly convex from before backwards, inasmuch as the faces of the cast present the converse contours in these directions. Furthermore, at some points, the posterior plate must have slipped forwards and inwards under that which preceded it, for the backwardly projecting ridges of the natural cast are formed by the sandstone, which has been, as it were run in between the displaced posterior edge of the one plate and the anterior edge of the next. The cavity underneath each ridge should therefore give the form of the anterior edge of one of these plates; and, on examination, it shows that, like the ventral scutes, the dorsal plates were terminated by a bevelled-off anterior articular facet. The analogy of *Teleosaurus* (Plate XII., fig. 1c.) and of *Caiman* (Plate XIII., fig. 1) leads to the suspicion that each dorsal plate of the tail was composed of two scutes united by suture in the median line; and though the impression of the inner edges of the scutes of each side are not very distinctly traceable, sufficient remains to show that there really were two distinct series. The outer edges of the scutes were truncated and rather produced at their anterior angles. In fact, the general form of each dorsal scute would be represented by a broad parallelogram of bone, bent upon itself along a longitudinal line drawn nearer the inner than the outer margin.

The anterior dorsal plates of this fragment of the tail are larger than the posterior ones; the most anterior measuring not less than 3½ inches transversly, by 2 inches antero-posteriorly. The three anterior ones correspond very nearly with the three anterior zones of ventral scutes; but, while, in the fourth zone, the ventral scutes are displaced a little backwards, the dorsal plates have slipped forwards; whereby the posterior edges of the dorsal scutes nearly correspond with the middle of the ventral scutes. This displacement is continued in the succeeding zones, whence the greater number of dorsal than of ventral scutes.

The angulated scutes of Stagonolepis.—Although this interesting specimen affords complete information as to the general form of the inner surfaces of the dorsal scutes, it tells nothing of the appearance of their external surfaces, the sandstone mould of the exterior of the scutes, in which the specimen doubtless lay loose, not having been preserved. But a considerable series of scutes and their casts have been obtained, all of which are bent or angulated in the same way as, though, usually, to a less extent than, the dorsal scutes of the caudal fragment; and partly on this ground, and partly by analogical reasoning, from the characters commonly presented by the dorsal scutes of crocodilian reptiles (Plate XIII., fig. 1. and 1e), I have no hesitation in referring these *angulated* scutes to the dorsal region of the body of *Stagonolepis.*

Various examples of such scutes are represented in Plate II. Two chief forms are readily distinguishable; the one much broader than they are long (Plate II., figs. 1, 2, 3, 10, 11); the others (Plate II., figs. 4, 5, 6) longer than broad; but, occasionally, scutes are met with (Plate II., figs. 7, 8, 9) which are transitional in form between these two extremes, and then are remarkably thick. In the *broad angulated scutes* the antero-posterior diameter of the scute may be less than half its transverse diameter (Plate II., fig. 2), but, in some, the two dimensions approach equality. The anterior edge (directed downwards in all the figures) is straight or slightly concave forwards. The posterior edge may be straight or sinuous, or produced in correspondence with the ridge on the outer face. The median edge is straight and cuts the line of the anterior edge at a right angle. The lateral edge is curved or sloping, with the postero-lateral angle rounded off. The ventral surface is smooth and concave from side to side, the deepest part of the concavity forming a longitudinal depression which is situated nearer the median than the lateral edge of the scute. In correspondence with this, the dorsal surface of the scute presents a more or less marked ridge, which not unfrequently runs out posteriorly into a projecting spine. The scute is thickest in the region occupied by this ridge, and especially in its posterior part. Immediately behind the whole length of the anterior margin, the dorsal face presents a narrow smooth surface by which the scute articulated with that which preceded it. The rest of this dorsal face is ornamented by a series of depressions which radiate from the ridge, and have the form of pits close to the ridge, while they become elongated grooves further away from it. It is obvious from the form of these scutes that, like the more strongly bent scutes in the caudal region, they formed a double series along the middle line of the back, each scute being articulated by its median edge to one of corresponding form and size upon the opposite side of the median line; while the pair thus formed overlapped the pair which succeeded them, and were overlapped by the pair which preceded them.

The largest specimens of dorsal scutes I have met with do not exceed five inches and a half in transverse, and two inches and a half in antero-posterior, diameter.

Stagonolepis, therefore, possesses a dorsal shield composed of dermal ossifications, and consisting of two longitudinal series of angulated scutes arranged in pairs, each pair articulating with the pair in front of and behind it. In the caudal region of the body, the scutes of the dorsal shield are greatly bent, so as to roof over the top and sides of the tail, and their lateral edges probably united with those of the ventral shield as they do in recent *Jacares* and *Caimans* (Plate XIII., fig. 1b.). The lateral edges of the scutes of the dorsal shield in the rest of the body, on the other hand, are free; and, as in those existing *Crocodilia* which possess a ventral armour, were united with the ventral shield only by the integument. These scutes are less bent and may be nearly flat, but always present a ridge, which often ends behind in a point. *Stagonolepis* also possesses a ventral shield made up of similar dermal ossifications, which were flat and devoid of any ridge. These scutes are rectangular and are disposed in longitudinal rows, of which only two appear to exist in the tail, while there are probably six, or in some parts eight, in the thoraco-abdominal region. Each ventral scute has an anterior smooth facet, and is overlapped by and overlaps its predecessor and successor, as in the dorsal shield; and the straight median and lateral edges of each scute are suturally united with those of adjacent scutes, except in the case of the lateral edges of those scutes which formed the lateral series on each side. Thus, in the thoraco-abdominal region, the ventral armour forms a series of flat and wide bands, each made up of six or eight firmly united pieces, and overlapping the band which follows it; while, in the same region, the dorsal armour is composed of less wide, ridged bands, each made up of only two pieces.

The *narrow angulated scutes* exhibit no articular surfaces or straight edges for union with other scutes. They probably were situated in the integument, between the dorsal and ventral shields and on the limbs, as in recent *Crocodilia.* (Plate XIII., fig. 1d.)

As is the case with the dorsal scutes, each ventral scute is composed, so far as I have been able to observe, of only one piece of bone, the anterior part of the scute, which bears the articular facet, not being separated from the rest by a suture. In this respect they differ from the ventral scutes of *Jacare* (Plate I., fig. 3) and of *Caiman* (Plate XIII., fig. 1f.)

2. *The Vertebræ and the Ribs of Stagonolepis Robertsoni* (Plates I., III., IV., V., VII., VIII., X.).

The atlas and axis have not yet been discovered; but I have other cervical vertebræ and vertebræ from the thoracic, sacral, and caudal regions. In all these vertebræ, the articular facets at the anterior and posterior ends of the centra are slightly concave. The cervical vertebræ (Plate I., figs. 6 and 7) have the contours of these facets nearly as broad as they are high, and the centra themselves are short and but little contracted in the middle.

In the thoracic vertebræ (Plate I., fig. 5; Plate V., figs. 2 and 3; Plate VII., fig. 2,) the contours of the articular faces of the centra are oval, the vertical being greater than the transverse diameter; the centra themselves are elongated and much narrower in the middle than at the ends.

In the sacral vertebræ (Plate V., figs. 4, 4a, Plate X., fig. 10), the articular faces of the centra are broader than they are high; while, in the caudal region (Plates III., IV., figs. 2 and 4, VII., figs. 1, 4) they nearly return to the form of those of the thoracic vertebræ.

In some of the vertebræ both of the thoracic and caudal regions, the articular faces of the centra of the vertebræ are not disposed at right angles to the axis of the centrum, but have a slight inclination from above downwards and backwards (Plate V., fig. 2; Plate III., fig. 2). In the thoracic region, the spines of the vertebræ are stout and broad from before backwards, but not very high (Plate VII., fig. 2). They are lower in the anterior part of the tail (Plate IV., fig. 2; Plate VII., fig. 1), and disappear altogether in the posterior part of this region (Plate VII., fig. 4). These, like the other processes of the vertebræ, are altogether similar in their general characters to those of existing *Crocodilia,* but the thoracic vertebræ are remarkable for the very strong upward inclination of their transverse processes. Living *Crocodilia* vary in the degree in which this bending upward of the transverse processes of the thoracic vertebræ takes place, but in none that I have met with is the inclination so great as in *Stagonolepis.*

The fragmentary cast of part of a sacral vertebra, from Findrassie, represented in Plate V., figs. 4, 4a, was among the earliest of the specimens which came into my hands, but it is only within the last four years that, thanks to Dr. Gordon, I have been able to obtain satisfactory evidence as to the nature of the posterior lumbar, and of the sacral vertebræ. This evidence is yielded by a shattered block of Lossiemouth sandstone, which contains the posterior two lumbar vertebræ, with the two sacral vertebræ, of one individual, and very nearly in their natural relation to one another. The first caudal is also present, but it is slightly displaced; and, near the first caudal, there lies the centrum of a vertebra which belongs to the middle region of the tail. The impression of a scute on one portion of the block leaves no doubt that the whole of the vertebræ belong to *Stagonolepis*. Most of the osseous substance of the vertebræ has disappeared, and the specimen is in such a condition that it would be difficult to give intelligible drawings of it. On the other hand, since it is broken in such a manner as to give sections in various directions, the data obtained by these sectional views may be so combined as to restore all the essential features of the bones with sufficient accuracy (Plate X., fig. 10).

The centrum which is best preserved is that of the hinder lumbar vertebra. It is 1·9 in. long, and its terminal articular surfaces are 1·8 in. broad by not more than 1·4 in. dorso-ventrally. The articular surface is rather deeply excavated, and has a transversely elongated oval form. The middle part of the centrum is constricted, so that the whole centrum has somewhat the shape of a dice-box. The centra of the two sacral vertebræ are similar in form and dimensions to that of the last lumbar, though less constricted; and they are not ankylosed together. The cast of the centrum of the first caudal vertebra has been somewhat distorted, but it appears to have differed from that of the second sacral in being somewhat shorter. Nothing is left of the centrum of the penultimate lumbar vertebra.

The spinous processes of the lumbar and sacral vertebræ are short and stout, while their dorsal ends are thickened and expanded, as if for the attachment of the scutes of this region. The transverse processes of the penultimate lumbar vertebra are strong, flattened dorso-ventrally, and very slightly recurved, but not inclined dorsally or ventrally. Their antero-lateral angles are rounded off; hence, at their free extremities, they are slightly narrower than at their origins. The distance from the free end of the one to that of the other is about 7 inches.

In the last lumbar vertebra, the transverse processes, though still flattened dorso-ventrally, stand straight out, and are broader at their truncated free extremities than at their origins. In fact, the antero-posterior measurement of the free end is 1·8 in., or nearly the same as that of the centrum of the vertebra. The ribs of the anterior sacral vertebra are strong flattened bones connected with almost the whole length of the centrum and arch; they widen as they pass outwards, until the free ends measure 2·5 in. antero-posteriorly. The outer ends of these ribs are truncated obliquely, the surfaces for the articulation of the ilia being directed outwards and backwards. The ribs of the second sacral vertebra are still broader, their concave posterior edges sloping rapidly backwards. Their articular surfaces are directed outwards and forwards, meeting those upon the ends of the ribs of the first sacral vertebræ at an obtuse angle. In the first caudal vertebra, the spine is more slender, both absolutely and proportionately to the centrum, and rather longer than in the sacral vertebræ. The free end is not expanded.

The characters of the caudal vertebræ in the anterior half and middle of the tail are very well shown in Plate III., fig. 2; Plate IV., figs. 2 and 4, and Plate VII., fig. 7.

The centra of these vertebræ are all more or less constricted, and have concave anterior and posterior faces of a vertically elongated oval form. Facets for the articulation of the subvertebral bones are visible on the ventral side of both the anterior and posterior articular surfaces, but they are more marked on the posterior face. In the anterior moiety of the caudal region, the spines are strong but somewhat short, the total height of the vertebræ not exceeding three times that of the vertical diameter of the anterior face of the centrum. The anterior edge of the spine slopes more or less backwards.

Such remains of the subvertebral or chevron bones, as are preserved in the cast of the caudal fragment, show that they were long and slender (Plate IV., fig. 4).

The centra are not ankylosed with the arches of the vertebræ, but are connected with them by rugose synchondrosial faces (Plate III., fig. 2). There is no trace of any suture between the transverse processes and the neural arches. In the only posterior caudal vertebra I have seen, the spine has altogether disappeared, and there are no certain indications of transverse processes (Plate VII., figs. 4, 4a). This vertebra may not belong to *Stagonolepis*.

3. *The reconstruction of the Vertebral Column of Stagonolepis from the foregoing data.*

In a specimen of *Crocodilus biporcatus*, 82 inches long, the skull measures 11·5 inches; the nine cervical vertebræ, 9 inches; the series of 15 thoraco-lumbar vertebræ, 18 inches; the two sacral vertebræ, 2·5 inches; the 35 caudal vertebræ, 41 inches, in length. Including the posterior convexities, the centra of the axis, and of the following five cervicals, are each 1 inch long; while those of the eighth and ninth vertebræ are a little shorter, or about 0·9 inch.

The transverse diameter of the centrum of the third cervical is 0·75 inch, its vertical diameter 0·7 inch. The transverse diameter of the ninth cervical is 1·3 inch, its vertical diameter 0·85 inch. The centra of the thoraco-lumbar vertebræ are all about 1·1 inch in length, and 0·7 inch or 0·75 in vertical diameter. The articular faces of the first thoracic and of the last lumbar centrum are broader (1·0 inch) than the fifth thoracic, which is about 0·7 inch. As far as the ninth thoraco-lumbar, the transverse processes of these vertebræ are inclined, though very slightly, upwards and backwards; those of the tenth, eleventh, and twelfth vertebræ stand straight out; those of the thirteenth and fourteenth are slightly recurved, while those of the fifteenth pass directly outwards.

The distance between the extreme ends of the transverse processes of the first thoracic vertebra is 2·7 inches. This distance goes on increasing to the ninth, when it reaches 4·25 inches, and then diminishing to the last lumbar, where it is only 3·1 inches.

The extreme distance between the ends of the anterior sacral ribs is 4·5 inches; between those of the posterior sacral ribs, 3·8 inches. The centrum of the first caudal vertebra is 1·1 inch long, and about 0·7 inch in vertical measurement; in the fourth the length is somewhat greater (1·2 inch), and this length is kept up to the posterior fourth of the tail. The vertical measurement diminishes to 0·4 in the middle of the tail, and becomes still less towards its extremity.

The sacral vertebræ of *Stagonolepis* above described, therefore, are larger than the corresponding vertebræ of a *Crocodilus biporcatus*, 6 feet 10 inches long, in the ratio of 19 to 12; and if the proportions of this Crocodile were retained throughout the vetebral column of *Stagonolepis*, the largest thoracic vertebræ (Plate V., fig. 2) yet met with, the centrum of which is only 1·3 inch long, is too small, by at least a third, to have belonged to an individual of similar dimensions. The same remark applies to the cervical vertebræ and to all the caudal vertebræ, which would fit very well into the same series as the thoracic vertebræ, but are too small for the sacrum.

The centra of the cervical vertebræ of the Crocodiles are, on the average, shorter than those of the thoracic series. In the *Crocodilus biporcatus* referred to, for example, the total length of the nine cervical vertebræ is only 9 inches, which gives an average of only 1 inch for each.

The centrum of the middle cervical vertebra, figured in Plate I., figs. 6, 6a, is 0·75 inch long, or shorter than in the *Crocodilus biporcatus*, whilst its vertical measurement, 1·1 inch, is greater than that of a corresponding vertebra in the recent Crocodile. Whence it would appear that the neck of *Stagonolepis Robertsoni* was somewhat shorter than that of *Crocodilus biporcatus*, if, as there is every reason to believe to be the case, it contained no greater number of vertebræ.

The distance between the apices of the transverse processes of the lumbar vertebræ in the *Crocodilus biporcatus* is 3·1 inches, or less than half the corresponding admeasurement in *Stagonolepis*, so that the latter had these processes relatively much longer. But, when *Stagonolepis* is compared with *Crocodilus vulgaris*, this difference in the length of the transverse processes of the lumbar vertebræ does not exist; in fact, these and the sacral vertebræ of *Stagonolepis* have very nearly the dimensions of the corresponding bones in a Nile Crocodile, 114 inches long, in the Museum of the University of Oxford.

Moreover, there is another interesting point of resemblance between the vertebral column of *Stagonolepis* and that of the Nile Crocodile. From the tenth (or first thoracic) to the fifteenth (fifth thoracic) vertebræ inclusively, in the latter, the transverse processes are inclined obliquely upwards and backwards, to a far greater extent than in *C. biporcatus*, the inclination being most marked in the four most anterior thoracic vertebræ; while, from the fifteenth vertebra backwards, the transverse processes trend almost directly outwards, or are horizontal.

In *Stagonolepis*, this character of the anterior thoracic vertebræ is somewhat exaggerated; but the remains of the penultimate lumbar vertebra show that, as in the Nile Crocodile, the transverse processes become horizontal in the posterior moiety of the præsacral region.

In the *Crocodilia* with complete dermal shields, each transverse row of dorsal scutes in the thoracic region answers to a vertebra (Plate XII.); consequently, the average antero-posterior dimensions of such a scute will be equal to the average length of the centrum of a thoracic vertebra, plus a certain addition for the overlapping and overlapped edges. Hence the scute, which answered to the thoracic vertebræ belonging to the specimen of *Stagonolepis*, the sacrum of which has been described, should have measured somewhat more than 2 inches antero-posteriorly.

As I have stated above, the largest dorsal scutes I have met with measure 2·5 inches in antero-posterior length, and, therefore, are large enough to have belonged to a *Stagonolepis* of the size indicated by the fragmentary sacrum.

The Ribs.—Only a few ribs have been obtained, and these were always in a very bad state of preservation, or mere casts. Fig. 6, Plate VII., represents the reproduction of the cast of the proximal end of an anterior vertebral rib from Findrassie. Fig. 5 on the same Plate is part of a more posterior vertebral rib from Lossiemouth, half the natural size. The capitular and tubercular facets are disposed in the same way as in the Crocodiles, and the face of the rib is concave from side to side. Measured in a straight line from one end to the other, the rib represented in Fig. 5, had a length of 9 inches, and a breadth of 0·6 inch. A fragment of a rib, which is complete at neither end, embedded in the same block of sandstone as the sacral vertebræ, is also 9 inches long and nearly 0·6 inch wide at its narrowest part. The one edge of this rib is straight throughout; but, at about 2 inches from one end, the other edge becomes convex, and the breadth of the rib gradually increases to 1·0 inch, but narrows again towards the end of the rib.

Another fragment, imperfect at each end, of about the same length, shows that one face of the rib presented a deep groove separating the outer margin from the rest of the surface of the rib, which is strongly convex. The groove and the convexity occupy the vertebral or proximal half of the rib, the sternal half of the same face being flattened.

I have met with no traces of sternal ribs or sternum; but it was hardly to be expected that mere calcified cartilages should be preserved under conditions which have been so unfavorable to the conservation of even the most complete bone.

The length of the chord of the curve of the largest vertebral rib of the *Crocodilus biporcatus* is 4·1 inches. Thus the vertebral ribs appear to have been longer in proportion in *Stagonolepis;* though, in the absence of the vertebræ to which they were attached, it is impossible to arrive at any safe conclusion on this head.

4. *The Skull of Stagonolepis Robertsoni* (Plate V., fig. 1.; Plate IX., figs. 1, 2, 3).

In my first essay on *Stagonolepis,* I gave a brief description of the impression of a mandible with long and strong teeth from Findrassie, and I stated that I saw no reason to doubt that it might belong to *Stagonolepis,* though positive proof was wanting.

This mandible is figured in Plate IV., fig. 1, and its nature will be a subject for future discussion. But that it is not the jaw of *Stagonolepis* has been rendered certain by the discovery of fragments of skulls, provided with teeth of a totally different character, associated with bones and scales of *Stagonolepis,* in such a manner as to leave no question that they formed a part of the same animal.

Much mutilated fragments of the anterior region of two skulls, one larger than the other, have been met with.

The smaller (Plate IX., fig. 1, fig. 1a) consists of a sandstone core (Fig. 1) which is a cast of the interior of the frontal region and of the adjacent part of a prolonged rostrum; its surface exhibits some adherent bone and impressions which show the form of the palatine region. Only so much of the counterpart (Fig. 1^a) as covered the anterior dorsal and the left lateral region of the core is preserved; but it is important because much of the bone which entered into this region still adheres to the sides of the cavity into which the core is received. It is not easy to give intelligible figures of this fragment; but, by putting together the data derivable from the study of the appearances which it presents, it is possible to determine several important points in the structure of the skull.

The length of the dorsal region of the skull which is preserved is 4·5 inches. In front it is 0·65 wide, but it gradually widens until, at 3·5 inches from the anterior end, it attains the width of 1·8 inch, and this it retains to its extremity.

Viewed sideways (the long axis of the skull being horizontal) the dorsal contour is at first parallel with the axis; it then slopes somewhat abruptly upwards to the point at which the fragment attains its greatest breadth.

The height of the fragment is, in front, 1·1 inch; behind, more than 2 inches. The ventral face is much broader than the dorsal face, behind, so that the sides slope outwards and downwards; in front, the difference of the breadth of the dorsal and ventral faces is less, and the sides of this part, which forms the commencement of the rostrum, are more nearly parallel.

For a distance of 2·5 inches from the posterior end, the outer face of the thick bony mass which forms the roof of the skull is sculptured by irregular radiating elevations and depressions; but, in front of this, the surface is smooth.

A very distinct median suture traverses the whole length of the roof, but no other sutures are discernible.

The bony plates which form the roof of the anterior, narrower, rostral part of the skull (Plate IX., fig. 1ᵃ, *a*) are flat and 0·15 inch thick; and, for a distance of 1·9 inches from the anterior end, their outer edges are well defined and rounded, and form the dorsal boundary of a vacuity which lies at the sides of the rostrum (Plate IX., fig. 1ᵃ, *b*). The posterior boundary of this rostral vacuity is formed by the anterior concave edge of a broad plate of bone, continuous with the roof above, which passes downwards and a little outwards, and constitutes the lateral wall of the skull behind the vacuity, becoming very thick inferiorly. Thus it is clear that, on each side of the rostrum there was an elongated aperture which measured not less than 0·6 inch vertically; while, antero-posteriorly, it was certainly 1·9 long and may have been much longer. This aperture may be termed the *rostral vacuity*.

The dorsal half of the broad plate of bone, which bounds the rostral vacuity behind, passes into the side walls of the cranium; but its ventral half presents a free edge, concave backwards (Plate IX., fig. 1ᵃ, *d*), which formed the anterior boundary of a large fossa, the inner wall of which is constituted by the parietes of the cranium, while the posterior boundary consists of a broken pillar of bone, which extends downwards and outwards from the posterior end of the broad part of the skull. The outer boundary of this *lateral fossa* is for the most part destroyed, but it is evident that it was strong and outwardly arched. Remains of teeth attached to the arch are traceable in its fore part and a mandibular tooth is adherent to its middle. The two rami of the mandible, the impressions of some of the teeth of which are traceable, converged to their symphysis in front of the anterior end of the fossa.

The oral face of the rostrum (Plate IX., fig. 1, *a*) is preserved for little more than an inch from its anterior end. In the middle, it presents a raised longitudinal ridge marked in the centre by a narrow groove. On each side of this ridge the surface is slightly excavated from side to side. The alveoli, with the teeth, have vanished, a broken surface of bone occupying their place. In the middle line, the bone which constitutes the floor of the rostrum, for this distance, is continued backwards in the form of two slender, almost vertical plates, between which the anterior end of a thick elongated median osseous style divided into two portions by a deep groove is received (Plate VIII., fig. 1, *b*). On each side of the central style thus constituted is a large oval opening (Plate IX., fig. 1, *c*), the anterior part of which lies under the posterior portion of the lateral aperture of the rostrum; these are, without doubt, the posterior nares. They are bounded behind by the impressions of the concave anterior edges of the palatine bones. The impressions of the palatine faces of these bones are at first inclined forwards as well as downwards, so that the edges which bound the posterior nostrils must have been much nearer the dorsal surface of the skull than the alveolar margin of the maxillæ. But they are united with the inner faces of the maxillæ laterally; and, posteriorly, they come to the level of the maxillæ and probably pass into the pterygoids.

An indication of an irregularly oval post-palatine foramen lies between the impressions which indicate the positions of the maxillæ, the posterior part of the palatine, the pterygoid, and the transverse bone.

The especial interest which attaches to this fragment of a skull lies in the fact that it affords trustworthy evidence of the manner in which the primitive posterior nares were constituted in *Stagonolepis.*

The primitive posterior nares are situated far forwards, as in Lizards, and neither the palatine nor the pterygoid bones send off those prolongations which, in existing *Crocodilia,* surround the nasal passages and give rise to the secondary posterior nares, placed far back, beneath the basisphenoid. Nevertheless, the arrangement of the bones which surround the posterior nares is still distinctively and characteristically crocodilian.

In recent *Crocodilia,* the pterygoid is ankylosed with its fellow in the middle line, and thus gives rise to a large single bone which may be distinguished into a median "body," and five processes, one anterior and four lateral. The dorsal face of the body is inclined somewhat backwards; it is excavated from side to side, and presents numerous ridges and furrows by which it articulates with the ventral and anterior face of the basisphenoid.

In front, it is continued by a sharp longitudinal ridge, which lies beneath the rostrum of the basisphenoid, into the anterior process. This is at first broad, convex from side to side, and furrowed by a deep median groove; but, anteriorly, the groove grows deeper, and the tapering anterior end of the bone is composed of two thin vertical plates united below, and forming a sheath for the under face of the interorbital or presphenoidal cartilage.

The edges of this anterior, or *palatine,* process of the pterygoid unite at first with the palatine bones; then, for a short distance, just where the thin sheath begins, with the descending process of the prefrontal, while the outer faces of the sheath itself are received between the posterior ends of the vomers.

The two principal lateral, or *transverse,* processes of the conjoined pterygoids are exceedingly broad and almost square, with thick external edges and thinner excavated posterior margins. The anterior edge of the transverse process unites internally with the transverse bone, while the outer and posterior edges are free. On the ventral face, along the line of junction of the transverse processes with the body, strong horizontal plates are sent in; and, meeting in the ventral middle line, form the inferior wall of the pterygoid portion of the nasal canal. The suture in which they unite persists, and from the junction of the two horizontal plates a vertical plate is sent up, which meets in the middle line with a ridge, which is the backward continuation of the anterior sheath-like process. The posterior part of the nasal passage is thus divided by a vertical septum.

The remaining pair of processes pass up on the sides of the basisphenoid and there articulate with the quadrate bones. These *quadrate* processes are small and flat, smooth externally, but rough internally, where their sutural surface is continuous with that on the dorsal aspect of the body.

Thus, by the most anterior part of its palatine process, the pterygoid furnishes a longitudinal septum to the middle portion of the nasal canal; behind this, it gives rise, not only to the septum but to the roof of this canal on each side; and, from the base of the median process onwards, it furnishes septum, roof, side walls, and floor. It is the portion which forms the roof, together with the adjacent part of the palatine, which in some Crocodiles, and especially in Gavials, becomes dilated, constituting the well-known bulla of the latter.

The dorsal portion of each palatine bone is thin and elongated, and is united by a short ascending process with the descending process of the prefrontal. Behind this, the inner edge of the palatine articulates with the median process of the pterygoid, which thus separates the two palatines from one another. In front, it unites by harmonia with the outer edge of the vomer, and ends by a thin margin, which is concave forwards, and lies far id front of the anterior margin of the orbit. This thin margin bounds the primitive posterior nares behind. At the sides, the dorsal portion curves round, and enters into the lateral walls and the floor of the nasal passage. The horizontal processes, which constitute the floor, join and send up a median process, as in the case of the pterygoids; and this median process, uniting posteriorly with the anterior process of the pterygoid; dorsally, with the vomer; and anteriorly with the maxillæ, gives rise to the median septum of the anterior portion of the nasal passage.

The vomers are thin, vertically elongated, plates of bone; together they form a sheath comparable to that furnished by the anterior process of the pterygoid, which is received between their posterior ends. In front, they extend for some distance beyond the palatines on to the dorsal surface of the palatine plates of the maxillæ; but they are separated by a considerable interval from the premaxillæ, though these sometimes send back long processes, over the palatine plates of the maxillæ, towards them.

In order to compare the bones thus described with the corresponding bones in *Stagonolepis*, the osseous plates furnished by the pterygoids and palatines to form the lateral and ventral walls of the posterior nasal canals must be cut away. The primitive posterior nares will then be seen to lie between the septum formed by vomers and the anterior process of the pterygoid in the middle, the palatines behind, and the maxillæ in front and at the sides. And it will be seen that the region of the dorsal wall of the skull which is placed directly over them, lies at some distance in front of the orbits, and corresponds, roughly, with the anterior limits of the lachrymal bones.

When the skull of a Gavial is taken for comparison, the position of the primitive posterior nares, in relation to the base of the rostrum and to the hinder maxillary teeth, is seen closely to correspond with that of the same parts in *Stagonolepis*. The chief difference is that the primitive posterior nares are smaller, the post-palatine foramina larger, and the palatine bones narrower in proportion, in the Gavial, than in *Stagonolepis*. But the median styliform grooved bone in *Stagonolepis* answers to the anterior process of the pterygoid in the Crocodiles, and the lamellar processes on each side of it to the vomers of the recent species; and it is exactly this arrangement which is not met with in Lizards and is characteristically crocodilian.

Stagonolepis, therefore, has distinctively crocodilian vomers, palatines, and pterygoids, but it differs from existing Crocodiles in the absence of those descending plates which shut off the nasal passage from the mouth in the latter, and give rise to the secondary posterior nares.

The interpretation of the rostral vacuities and of the lateral fossæ is open to doubt.

In the *Teleosauria* (Plate XI., fig. 1, 1b) there are larger or smaller vacuities at the sides of the base of the rostrum, in the same position as those of *Stagonolepis*. They lie between the nasal and the maxillary bones, and in front of the lachrymals, whence they may be termed *prælachrymal vacuities*.

It is clear that if the rostral vacuities of *Stagonolepis* answer to them, the external nares must have been situated further forward, probably at the end of the rostrum, and the lateral fossæ will be the orbits.

But in *Belodon*, with which *Stagonolepis* has many and close affinities, the anterior nares are situated in a position corresponding with the rostral vacuities of *Stagonolepis*, though much closer together, on account of the extreme narrowness of the intervening portion of the nasal bones; while the prælachrymal vacuities, which are of enormous size, occupy the position of the lateral fossæ of *Stagonolepis*.

With the materials at hand, I do not think it is possible to decide positively whether *Stagonolepis* followed the type of the *Teleosauria*, or that of *Belodon*, but the probabilities seem to me to be in favour of the latter supposition. Whichever interpretation be adopted, the interesting fact results that, by its skull, *Stagonolepis* forms a link between the *Teleosauria* and *Belodon*. For, if the rostral vacuities are anterior nares, as in the latter genus, the breadth of the nasal bones between them is an indication of less divergence from the Teleosaurian than occurs in *Belodon*; and, if they are prælachrymal vacuities, their size, so much larger than in any known Teleosaurian, is an approximation to the characters of *Belodon*.

The other fragment of a cranium, of considerably larger size, is figured in Plate V., figs. 1, 1^a, 1^b. A maxilla (*b*) bears the remains of nine teeth, and indistinct impressions of two others. The hinder are smaller than the anterior teeth. All have swollen crowns, marked off by a constriction from the cylindrical fang. The crowns of the fifth and sixth teeth present flat surfaces produced by wearing against the teeth of the lower jaw. The inner part of the bone is much crushed, except in front, where its margin shows a natural edge (*a*) concave inwards. Posteriorly, the extremity of the maxilla passes into a curved osseous mass, which is indistinguishably crushed into the end of a long and flat, but thick bone (*c*), which lies on the left side of the figure. The fossil is broken along the oblique line which runs from the first tooth in front and on the right side, backwards and to the left; and when the piece which lies in front of the line of fracture is removed, the fossil presents the appearance represented in fig. 1^a. The natural edge of the long flat bone (*c*) curves outward in front, and joining with an ascending plate from the maxilla bounds an oval vacuity (*Or*) of which the anterior contour only is traceable. When the piece of the fossil which has been removed is turned round so as to show its dorsal face (fig. 1^b), it exhibits the ascending process of the maxilla (*d*), and the impression of the anterior part of the long flat bone (*c*) with the space (*Or*) which they partially inclose. Moreover, by clearing away the matrix in front of this, I exposed a fan-shaped plate of bone (fig. 1^b, *Vo*) broken in front, but with a natural free edge, which looks outwards and backwards. This bone is continued backwards into a laterally-compressed vertical plate (*f*), the ventral edge of which is seen in fig. 1.

It is not easy to interpret this fossil in perfect consistency with the structure of the skull, as already made out in the less disturbed fragment. But the most probable reading appears to me to be, that fig. 1, in front of the line of fracture, presents a view of the anterior boundary of the posterior nostril; while, behind the line of fracture, it shows the inner surface of the bones (*c*), which occupy the median line of the roof of the skull, and which must be either nasals or frontals.

Figures 1^a and 1^b give a view of the dorsal aspect of the skull, and show the anterior boundary of the oval space (*Or*) bounded in front by the ascending process of the maxilla (*d*). I was at first inclined to regard the space as the orbit; but I think it is more probable that it is the prælachrymal vacuity.

The fan-shaped bone must be the vomer, as it bounds the primitive posterior nostril internally and anteriorly, and is continued back into the vertical lamina, which separates the two nares.

However doubtful may be the interpretation of other parts of this fragment, it confirms the conception already formed of the structure of the posterior nares.

The Mandible.—Evidence respecting the form of the mandible is afforded by the specimens figured in Plate I., fig. 4, 4^a, and Plate VI., fig. 3 and 3^a. The former figure represents a portion of the two rami of the mandible close to he symphysis. At the left-hand extremity, the ventral edge of the ramus is entire, and it measures 0·7 inch vertically; at the opposite extremity, the contour of a transverse section is shown with a tooth in its alveolus. (Fig. 4^{a}.) This tooth is 0·7 long. In the adherent fragment of the upper jaw the remains of four teeth are seen, and it may be concluded that the fragment of the mandible, which is 2 inches long, bore six teeth.

In Plate VI., figs. 3, 3^{a} are the remains of a series of teeth, belonging apparently to the two rami of the mandible, for some distance before and after their junction in the symphysis. In this jaw, nine teeth occupy about 2·5 inches.

From these specimens, imperfect as they are, it may be concluded that the rami of the mandible were united in a long symphysis, as in existing Gavials and in *Belodon;* and this is what might be expected from the elongation of the snout.

The Teeth of Stagonolepis Robertsoni (Plate I., figs. 4 and 4a; Plate V., figs. 1 and 1^{c}, 1^{d}, 1^{e}; Plate VI., fig. 3^{c}; Plate IX., figs. 3, 4, 4^{a}).—Many teeth have been met with in close association with portions of *Stagonolepis,* or in the jaws. Putting together the information yielded by the specimens figured in Plate V., fig. 1, and Plate VI., fig. 3, it may be safely concluded that there were not fewer than twenty teeth on each side in each jaw. There is no evidence respecting the form of the most anterior teeth. The middle and posterior teeth are all very similar. The fang is subcylindrical, and is excavated by a large pulp cavity, as in Crocodiles. The crown is of a pear shape, tapering up towards an obtuse point. In section it is circular or broadly oval, except towards the apex, where it becomes lenticular. Even here, however, the anterior and posterior margins are not produced into ridges, and it is only in some teeth that a few inconspicuous and obtuse elevations, which may represent serrations, are to be observed (Plate IX., fig. 4^{a}).

The surface of the enamel is raised into irregular longitudinal folds separated by shallow grooves. Not unfrequently the crowns of the teeth present oval, flattened surfaces, obviously produced by wearing against the opposed teeth (Plate V., figs. 1^{c}, 1^{d}).

These teeth are, in fact, very similar to the hindermost teeth in living Crocodiles and Alligators.

The hindermost teeth in the maxilla are more slender than the others, and probably the same modification obtained in the teeth of the mandible. In the absence of the anterior portion of either upper or lower jaws, it would be unsafe to say that the foremost teeth might not have been elongated and sharp pointed, but it is exceedingly unlikely that they could have even approached the form and size of such teeth as those represented in Plate IV., fig. 1.

6. *The Bones of the Pectoral and Pelvic Arches and Limbs.*

Not a single entire bone belonging to these portions of the skeleton has presented itself. All are more or less broken, and the most instructive specimens are mere casts in sandstone. Under these circumstances the work of reconstruction has presented many difficulties, and it is only recently that I have been able to make sure of the structure of the pectoral arch and of the pelvis, and of the characters of some of the chief bones of the limbs.

The Scapula and the Coracoid.—The impression of the inner face of a scapula, of which a cast is represented in Plate VIII., fig. 3, is accompanied by impressions of scutes of *Stagonolepis* in a block of Findrassie sandstone; while the coracoid figured in the same Plate (fig. 1) is lodged in a large mass of Lossiemouth sandstone and is also accompanied by several dorsal scutes, all of which measure 5·5 inches in width by 2·5 inches in antero-posterior diameter. It may therefore be concluded that this coracoid belonged to one of the largest examples of *Stagonolepis*.

The scapula presents its smooth inner face, which is slightly concave from above downwards, to the eye. It is expanded at both ends, the dorsal extremity being thin, while the ventral end becomes very thick posteriorly, where it presents an obliquely truncated articular face which formed the dorsal half of the glenoidal cavity. In front it thins off, and is continued into a broad thin process, the anterior extremity of which seems to be imperfect. The ventral edge of the scapula presents a rough surface, broad behind and narrow in front, for articulation with the coracoid.

The vertical or dorso-ventral measurement of this bone is 5·6 inches. The greatest antero-posterior measurement of the dorsal end 1·95 inch, of the ventral end 2·55 inches; the greatest thickness of this end, 0·85 inch.

The *Coracoid* (Plate VIII., fig. 1) was almost wholly covered up by the matrix when it came into my hands; but careful chiselling away of the sandstone rendered visible an irregularly oval plate of bone, 4·8 inches long by 3·3 inches at widest, bounded on the one side by a regularly curved natural margin, while on the other it was much broken. As the bone is figured, its thickest part corresponds with the lower half of the broken portion, the upper half being thin. Just above the thick broken portion, a circular hole (0·3 inch) is seen. Regarding this as the homologue of the foramen in the coracoid of a Crocodile, I considered that the thick broken edge must correspond with the position of the glenoidal head of the coracoid, and consequently that the entire curved edge of the bone answered to the inner margin of the coracoid, or to that part of it which articulates with the sternum in a Crocodile. But if such be the case, it follows that the coracoid of *Stagonolepis* is very different from that of any known recent or fossil Crocodile, except *Belodon;* in which, so far as the generally oval form of the coracoid is concerned, a similar modification obtains. Von Mayer states that, in one of his specimens of the pectoral arch of *Belodon*, the scapula and coracoid were ankylosed. The scapula of *Stagonolepis*, already described, on the other hand, seemed to show that no such ankylosis occurred in this genus. Singularly enough, however, a more recently discovered fossil proves that ankylosis of these bones also occurs in *Stagonolepis*,—even in animals of smaller dimensions than that to which the coracoid represented in Plate VIII. belonged.

This important specimen (Plate X., fig. 1, 1[a]), lies on one face of a block of Lossiemouth sandstone, along with an ischium which crosses it, while, at no great distance on the under side of the block, there is an ilium. The total length of the two bones, from the ventral edge of the coracoid to the utmost limit to which the dorsal edge of the scapula can be traced, is 9·9 inches. The centre of the glenoidal cavity is 2·5 inches from the centre of the ventral margin of the coracoid, and as the line of this measurement corresponds pretty nearly with the transverse diameter of the coracoid, Plate VIII., fig. 1, it is clear that the latter bone is the larger. The same conclusion is derivable from the difference between the distance from the centre of the foramen to the summit of the convexity of the posterior edge, which is 2·5 inches in this coracoid, and 2·75 inches in the previously described bone.

In the present coracoid, the ventral edge is evenly curved from the glenoidal cavity to a line corresponding with the long axis of the ankylosed bones and drawn through the foramen. At this point, the ventral edge is met by the obliquely truncated, probably fractured, anterior margin, which then becomes nearly straight and meets the anterior edge of the scapula at an angle. The circular foramen is situated in a line drawn from this angle to the centre of the glenoidal face. The latter is concave from above downwards, convex from side to side and looks outwards as well as backwards. Below, it is bounded by a very prominent lip. The dorsal end of the scapula expands more rapidly than in the specimen already described, and attains a greater length than is indicated by the cast of the latter. Moreover, the form of the anterior process at the glenoidal end of the scapula differs in the two cases.

The scapula in the last-mentioned specimen has, as nearly as may be, twice the dimensions of the same bone in the *Crocodilus biporcatus*, 7 feet long.

The Interclavicle.—This bone, of which only one specimen has been met with, is represented of the size of nature in Plate X., fig. 2, and a side view of it is given in fig. 2a of the same Plate.

On comparing it with the corresponding bone (generally termed the sternum) in the skeleton of the *Crocodilus biporcatus*, which has already served as a standard of comparison, it is seen to correspond with the posterior two thirds of the latter in its general form and dimensions. However, it is slightly smaller, thinner, and more curved, and there is a more marked constriction between the posterior spatulate, and the anterior thicker and laterally-grooved portion of the bone.

The Ilium.—The bone, represented about three-fourths of the natural size in Plate VI., fig. 1, lies in a large block of

Lossiemouth sandstone along with the femur represented in same Plate (fig. 2), ribs, fragments of vertebræ, and numerous dorsal scutes, the largest of which is 5·25 inches wide by 2·25 inches antero-posteriorly. It is much broken, and consists of two divisions separated by a median constriction; the one division having a semicircular, the other a straight free edge. The total length of the bone, measured between lines drawn at right angles to the straight edge, is nearly 9 inches, while its greatest transverse diameter is 5·8 inches. For a long time, I took this bone to be a coracoid, but better specimens, which have come under my notice, prove it to be a right ilium of which only the injured inner face is displayed.

Two almost perfect impressions of the outer face of the ilium, both belonging to the right side, but one considerably larger than the other, have been obtained at Lossiemouth (Plate X., figs. 3 and 4).

The wide and shallow acetabular cavity occupies all that part of the external face of the bone, which in the specimen figured in Plate VI. is terminated by a semicircular edge. But it is seen that the corresponding edge of the perfect ilium is not truly semicircular, but is formed by two edges, one antero-inferior and the other postero-inferior. The postero-inferior edge is undulating, the antero-inferior straighter; but the two edges meet in an obtuse angle, and there is no trace of any notch or excavation in this border of the bone.

On the dorsal side, the acetabular cavity is bounded by a sharp projecting ridge continuous with its roof. In front, this passes gradually into the outer face of the thick and rounded pillar which bounds the acetabulum anteriorly. Behind, on the other hand, the ridge ceases suddenly at the level of the neck by which the ala of the ilium passes into its acetabular portion; so that a sort of shallow and broad notch lies between the end of the ridge and the thickened extremity of the posterior pillar, or hinder margin of the acetabular cavity. At the free ends of the two pillars, the ventral margin of the acetabular wall is very thick and rugose, that of the anterior pillar being half as large again as that of the posterior. Between these two the rest of the edge is thin.

The ala of the ilium, into which the acetabular portion of the bone passes dorsally, answers to the straight-edged division of the specimen figured in Plate VI., and is equal to about half the entire bone. The outer face is slightly excavated, and presents radiating striæ near its dorsal edge. The anterior half of the dorsal margin runs nearly parallel with the dorsal margin of the acetabulum. The anterior margin is long and concave forwards, so that the antero-superior angle is somewhat produced. The thick posterior margin, which is bevelled off to a flat surface above, is much more inclined than the anterior, and the postero-superior angle of the ileum is consequently much more prolonged than the antero-superior angle.

The following are the measurements of the ilia, No. I. being the specimen figured in Plate VI., and Nos. II. and III. the larger and the smaller ilia just described:—

—	I.	II.	III.	*Crocodilus biporcatus.*
	ins.	ins.	ins.	ins.
Length of the dorsal margin of the ala -	6·5	5·9	4·2	3·0
Vertical height of the ala, measured from the middle of the outer edge of the acetabulum.	—	2·1	1·5	0·8
Antero-posterior diameter of the "neck"	3·2	3·5	2·5	1·9
Outside antero-posterior diameter of the acetabular portion.	—	5·2	3·75	2·3

No. I. therefore is rather larger than No. II., and No. III. has about two-thirds of the size of No. II., while the latter is about twice as large as the corresponding bone of the *Crocodilus biporcatus.* The cast of No. III. lies on the under side of the block of sandstone, on the upper side of which, and separated from it only by a few inches, are the ankylosed scapula and coracoid, already discussed, and an ischium to be described immediately; so that there can be little doubt that all these bones belonged to the same animal.

It is obvious, from the form of the acetabular region of the ilium, that it must have constituted the greater part of the inner wall of the acetabulum, and that the segments of that wall which were furnished by the pubis and the ischium must have been relatively small.

The Ischium.—This bone (Plate X., fig. 5, 5a), has, roughly speaking, the form of a triangle, the base of which is formed by its anterior edge, while the two other sides are represented by the ventral and the dorsal edges. The latter is thick, rounded, and somewhat excavated, while the ventral edge is very thin. The apex or posterior extremity of the triangle is truncated and thick. The ventral half of its base, or anterior side, is formed by a thin curved edge, which bounded the obturator space behind. The dorsal half is constituted by an elongated articular surface, which looks upwards and forwards, and is concave from above downwards and from side to side.

This surface is 2·6 inches long, but is nowhere more than 0·7 wide. Its outer side is, bounded by a thick lip, which is very prominent at its dorsal extremity, but rapidly dies away and disappears, at about half an inch from the ventral end. The inner edge of the articular surface appears to have been thin and has an undulating contour. Where this segment of the acetabulum ends and the thin edge which bounds the obturator foramen commences, the latter presents an elongated facet 0·3 inch long, which would seem to have articulated with the pubis. At the dorsal end of the acetabular facet, the bone is thick and presents a broad surface for articulation with the posterior pillar of the acetabular portion of the ilium.

The outer or ventral face of the ischium is concave and is marked by striæ which are particularly conspicuous towards the ventral edge. The inner surface is slightly convex. The extreme length of this bone is 7 inches, its extreme width 4·2 inches.

The length of the acetabular articular surface of the ischium corresponds very closely with that of the postero-inferior, or ischial, portion of the ventral margin of the acetabulum in the smallest of the three ilia; and, as this ilium was found close to the ischium, I cannot doubt that they belong to the same animal, although the large size of the ischium in proportion to the ilium is somewhat remarkable.

The Pubis.—The only bone which I can regard as the pubis is that of which the most perfect specimen I have seen is figured, of the natural size, in Plate VIII. fig. 2. It is accompanied by the impression and part of the osseous substance of a scute. It is 6 inches long, flattened, comparatively narrow, and thick in the middle and wide at each end, the wider end having a well-defined convex margin and becoming very thin; this was indubitably the ventral or symphysial edge of the bone. One of the other two entire edges of the bone is longer and less excavated than the other, and I conceive it to have been anterior. The dorsal, or acetabular, end of the bone is much broken, but its anterior end was obviously thick, while posteriorly it was produced into a broad prolongation, which is thin and shattered towards its free end.

I suppose this process to have entered into the inner wall of the acetabulum, as in *Lacertilia.*

Whatever doubt may rest upon the character of the acetabular end of the pubis, the structure of the ilium and of the ischium conclusively proves that the inner wall of the acetabulum was formed by the union of all three pelvic bones; and that there was no vacuity, or notch, such as exists in the ilia of recent *Crocodilia* and of the *Ornithoscelida.*

The Femur.—On the same block of sandstone with the ilium figured on Plate VI., fig. 1, and close to it, lies the elongated bone represented in fig. 2 of the same Plate, in the position which it occupies relatively to the ilium. This bone has a length of very nearly 12 inches, while the end nearest the ilium, which is plainly the proper proximal end, is 3·5 inches broad. It is flattened and has a nearly straight margin, with the outer angle rounded off. From the proximal end, the bone gradually narrows to the middle of the sub-cylindrical shaft, which has a diameter of 1·5 inches. At the distal end it is hardly wider, but it is probable that part of the bone is broken away.

The exposed face of the proximal half of the bone is convex, that of the distal half concave, as the accompanying contour fig. 2a shows. On the free surface of the distal end there is a slight depression, indicating the commencement of the division between the condyles.

It will be seen from the table of measurements of the ilia, given above, that the ilium, in association with which this bone was found, was about twice the size of that of the 7-foot specimen of

Crocodilus biporcàtus. Now the femur of this Crocodile is just 6 inches long, so that the bone in question has the proportions that might be expected, if the limbs of *Stagonolepis* resembled those of ordinary Crocodiles.

In the Crocodile, the extreme width of the proximal end of the femur is 1·45 inches, that of the distal end 1·4 inches, or practically the same. Moreover, the plane of the proximal end of the bone is inclined at an angle of 45° to that of the distal end. Hence, when the two condyles rest on a flat surface, the dorsal face of the proximal end looks outwards and backwards, and its ventral face in the contrary direction.

The femur of *Stagonolepis* presents no such torsion; and, in this respect, as in the narrowness of the distal, relatively to the proximal end, it differs from the same bone in Crocodiles and in Lizards.

It may be suggested that the femur of *Stagonolepis* has been crushed and distorted, but another femur figured of half the size of nature in Plate VII., fig. 8, presents the same peculiarities.

The Humerus.—Such being the characters of the femur, the bone represented in Plate VII., fig. 7, can only be a humerus, though at first sight it looks much more like a femur. I have unfortunately no complete example of this bone, though three specimens of it, two large and one small, have come into my hands. That figured in Plate VII., fig. 7, is a gutta percha impression of a cast, which lies along with that of the bone, represented in Plate VIII., fig. 4, and with casts of dorsal and ventral scutes, of a rib, and of what appears to be a phalanx, in a block of Findrassie sandstone. The largest of these scutes do not measure more than 1·75 inches antero-posteriorly by 4 inches in width; whence the animal to which they belonged is by no means of the largest size. The scute represented in Plate II., fig. 1, is one of those on this block. I may mention that it was the discovery of this fossil which first led Dr. Gordon to suspect the reptilian nature of *Stagonolepis.*

The distal end of the bone measures about 2·7 inches in transverse diameter, and the impression of the shaft and proximal end are traceable for a length of 7·3 inches. The impression of a second and larger specimen of a similar bone, from Lossiemouth, measures 9·9 in length, and was probably considerably longer, the distal end having a diameter of 3·5 inches. On what appears to have been the radial side of the bone there is a projecting ridge separated by a groove from the shaft, which terminates by a rounded free edge opposite the middle of the larger condyle. A similar ridge is observable in the humeri of Lizards, *Chelonia, Dicynodontia,* and of *Belodon.*

The impression of a smaller humerus (Plate X., fig. 7) measures 7·3 inches in length, and only a very small portion can be wanting in the middle of its proximal end. The distal end and the shaft are nearly complete, but the articular head at the proximal end is broken away. The distal end measures 2·5 inches in transverse diameter, and the middle of the shaft about 1 inch; while what remains of the flattened proximal end is rather wider than the distal extremity.

If we take the proportions of this bone as a standard, the whole length of the humerus should be about three diameters of the distal end, which will give the following dimensions for the three humeri taking them in the order of size:

——	I.	II.	III.	Crocodilus biporcatus.
	ins.	ins.	ins.	ins.
Distal end	3·5	2·7	2·5	1·55
Total length	10·5	8·1	7·5	5·5

In the *Crocodilus biporcatus,* the extreme length of the humerus is 5·5 inches, the extreme breadth of the proximal end 1·45 in., and of the distal end 1·55 in. Hence the length of the bone in proportion to the latter diameter is as about 3½ to 1.

Thus the distal end of the humerus is slightly broader in proportion to its length in *Stagonolepis,* and, so far as any judgment can be formed from the specimens of femora, much broader in proportion to the distal end of the femur than in *Crocodilus biporcatus;* but the longest humerus, like the longest femur, is very nearly twice the length of that of the Crocodile; so that, if the longest femur and the longest humerus had belonged to the same animal, they would have had about the same relative proportions as in *Crocodilus biporcatus.*

In respect of the excess of breadth of the distal end of the humerus over that of the femur, the *Stagonolepis* approaches the Lacertilian type; and the approximation is still more marked in the expansion of the proximal end of the humerus exhibited by the casts figured in Plate X., figs. 6 and 7, and in the absence of that excavation between the deltoid ridge and the articular head which characterises the Crocodilian humerus.

The Radius or *Fibula.*—Fig. 4, Plate VIII., represents the cast of an impression of a bone which was found along with the humerus, Plate VII., fig. 7. The *primâ facie* probability therefore is that it belongs to the antebrachium, and, if so, it can only be the radius. In fact, the shape of the end which is upper in the figure agrees very well with the distal end of the radius in a Crocodile, while the opposite extremity accords with the proximal end. In other respects, the form of the bone is somewhat different; and indeed, if considered in the position in which it is represented, it presents so many points of resemblance to the fibula of a Crocodile that I was, at first, inclined to identify it with the latter bone. The length of this bone is 5·7 inches or 0·76 of the probable length of the humerus which accompanied it. In the *Crocodilus biporcatus* the radius is 3·5 inches long. As the humerus measures 5·5 inches, the radius has only 0·64 of the length of the humerus, and is therefore proportionately much shorter than in *Stagonolepis.*

The fibula of the same Crocodile is 4·25 inches long, or 0·77 to the humerus as 1; which is in close agreement with proportions of the present bone, supposing it to be the fibula. The marked angulation of the anterior contour, in which this bone resembles the fibula and differs from the radius, is, however, situated considerably below the centre of the bone and not midway between the centre and the proximal end, as in the Crocodiles and Lizards. Moreover, while the planes of the articular ends of the bone are sensibly parallel, as in the radius of both Crocodiles and Lizards, the planes of these two surfaces in the fibula of these reptiles are inclined at a large angle. On the whole, the preponderance of the evidence appears to me to be in favour of the interpretation of the bone as a radius.

The bone, represented of the natural size in Plate VII., fig. 9, lies in a block of Lossiemouth sandstone alongside a dorsal scute of the largest dimensions (5 inches by 2·5 inches). It is 7·5 inches long, and flattened at the ends, both of which are imperfect. The end, which is lower in the figure, is 1·75 in. broad, while the upper extremity is rather narrower. The one edge is evenly curved and rounded, the other is angulated by a projection which lies nearer the upper than the lower end of the bone. I suspect that this is a radius (or fibula) of larger size than the foregoing.

The Tibia (?)—The only specimen of a bone which will answer for a tibia, which I have seen, is that a cast of the impression of which is figured in Plate X., fig. 8. It is 9·2 inches long and 1·6 inches thick in the middle of its shaft, which is much bent. The upper end is obliquely truncated, the lower compressed, rounded, and with a well-marked antero-posterior depression, or groove, which divides the articular surface into two portions.

In the *Crocodilus biporcatus*, the tibia is 4·5 long, or 0·75 to the femur as 1; which is, as nearly as may be, the proportion of this bone to the longest femur of *Stagonolepis*, but of course it may have belonged to one of the shorter femora.

The impression of this bone is so imperfect that it would be unsafe to lay much weight upon the differences in form of the distal end of the cast from that presented by the distal end of a crocodile's tibia. But, if the articular surface for the astragalus has not been distorted, it would appear that this surface was more Lacertilian than Crocodilian in *Stagonolepis*. In fact, in the crocodile, when the trihedral proximal end of the tibia rests on a flat surface, with its obtuse crest turned upwards, the surfaces of the flattened distal end are seen to look respectively outwards and upwards, and downwards and inwards, *i.e.*, towards the axis of the limb. The plane of the distal end of the bone is, in fact, under these circumstances, inclined at an angle of 45° to that of the flat surface on which it rests, as I have shown to be the case in the tibiæ of *Ornithoscelida* and *Aves*. But the articular face itself has nearly the contour of the quadrant of a circle, being convex externally and concave internally. The long axis of that part of the articular surface which lies nearest the fibula is parallel with the surface on which the tibia rests, which the other moiety is elongated from before backwards.

In a Lizard (*e.g.*, *Varanus*), on the other hand, the distal end of the tibia is, like its proximal end, trihedral, and not flattened; in correspondence therewith, its articular surface is triangular in contour, and a broad pulley-shaped groove, which runs from before backwards, divides the inner from the outer projecting ridge. On the whole, therefore, the form of the distal end of the tibia of *Stagonolepis* (if the bone in question is correctly identified), appears to have been more Lacertilian than Crocodilian.

Bones of the feet.—I have met with no carpal or tarsal bones, and only a few imperfect impressions of bones which can be referred to the digits. Of these, one (Plate VIII., fig. 5) is exhibited by a piece of Findrassie sandstone, which presents no other impressions.

The bone is 2·25 in. long. Its proximal end is 1·15 in. wide, with a truncated articular surface, the exact form of which cannot be made out. The distal end presents a well-marked curved articular pulley, with an antero-posterior diameter of about half an inch.

From the general form of this bone, I think there can be no doubt that it belongs either to the metacarpus or the metatarsus, and to the first præaxial element (pollex or hallux) of the series. Its length is exactly the same as that of the metatarsal of the hallux of the *Crocodilus biporcatus*, and it would be very similar to that bone in form if it were not fully half as broad again.

The metacarpal of the pollex in the Crocodile has a length of only 0·9 inch, and its proximal end is much broader and more expanded, while the carpal articular surface is very convex.

In all probability, therefore, this bone is the metatarsal of the hallux; and if so, its proportions suggest that the hind foot was of a heavier and more massive form in *Stagonolepis* than in recent Crocodiles.

On the same block of Lossiemouth sandstone as that containing the radius, or fibula, figured in Plate VII., fig 9, there is the impression of what I take to be a metacarpal bone, the cast of which is represented of the natural size in Plate X., fig. 9. On the side of the distal articular head there is, as in Crocodiles, a well-marked pit for the lateral ligament.

The impression of a solitary phalanx 1·15 inch long and 0·4 inch in greatest transverse diameter is to be seen on the same slab as that which bears the impression of the humerus figured in Plate VII., fig. 7.

In my first paper on *Stagonolepis*, I mention having met with a "single natural cast of a long and nearly straight bone, which I can only regard as an ungual phalanx," indicating "a length of claw wholly foreign to the Crocodilian foot." The bone, as reproduced by taking an impression of the cast in question, is figured in Plate VIII., fig 6, of the natural size. The slab in which it occurs exhibits impressions of scutes and an imperfect cast of vertebra, so that there is every reason to believe that the bone formed part of the skeleton of *Stagonolepis.*

The bone is 3·65 inches long, asymmetrical, narrow, and thin at one end, but suddenly widens out and becomes thicker at the other, the extremity of which is obliquely truncated and presents an uneven, but smooth and apparently articular surface (Plate VI., fig 6^a). The surface of the expanded part presents many minute pits and grooves, somewhat resembling the pits and grooves which are to be seen on an ungual phalanx of a Crocodile, but there is no strong longitudinal groove such as marks the lateral faces of those ungual phalanges which are ensheathed in claws in the Crocodilia.

The longest ungual phalanx, that of the hallux, in the *Crocodilus biporcatus,* is only an inch long, is more curved and pointed at the apex, and its articular surface is altogether different.

There is no reason to believe that a bone of this character could have formed any part of the exoskeleton, and I am at a loss to know to what part of the endoskeleton it can be referred, except the manus or the pes. My original supposition, that the bone is an ungual phalanx, is opposed by its great length and by the absence of the lateral grooves; though it might be suggested, that it belonged to a digit which, like the two postaxial digits in the Crocodile, was devoid of a nail. In this case, however, the great length of the bone would be even more anomalous.

Perhaps it represents the fifth metatarsal, which, though short and rudimentary in the recent Crocodiles, may well have been larger in so ancient a form as *Stagonolepis.*

III.—THE TAXONOMY, OR SYSTEMATIC POSITION, OF STAGONOLEPIS ROBERTSONI.

From what has been stated in the preceding pages, it is clear that *Stagonolepis* must have resembled a modern Caiman, with strong limbs, of which the anterior were at least as large in proportion to the posterior as in *Crocodilus biporcatus,* but with a relatively long and narrow skull, like that of a Gavial.

As in the existing Caimans and Jacares, the trunk and tail were provided with ventral, as well as with dorsal, osseous scutes; but the dorsal shield contained not more than two longitudinal series of scutes, and the ventral shield not more than eight such series. The dorsal and the ventral shields were distinct in the trunk, but united together in the tail. The dorsal scutes were angulated and carinated; the ventral scutes were flat and composed of a single ossification.

The vertebræ were amphicœlous: the anterior and posterior faces of the centra being slightly concave. The transverse processes of the anterior thoracic vertebræ resembled the corresponding processes in some recent Crocodiles (e.g., *C. niloticus*) and in *Belodon,* in being much inclined upwards.

The transverse processes of the lumbar vertebræ were long broad, and directed horizontally; and the free ends of those of the last lumbar vertebra were expanded.

The sacrum consisted of two amphicœlous vertebræ, which were not ankylosed. The free ends of the sacral ribs were remarkably expanded, more so than in any known Crocodile.

The centrum of the first caudal vertebra was amphicœlous, and the subvertebral bones resembled those of Crocodiles.

The anterior region of the skull was produced into a slender rostrum, and the rami of the mandibles united in a long symphysis. The posterior nares were situated far forwards, as in Lizards; and neither the palatine, nor the pterygoid bones, united to prolong the nasal passage backwards and give rise to secondary posterior nares, as they do in existing Crocodiles. In the mode of formation of the primitive posterior nares, however, *Stagonolepis* conformed to the Crocodilian type.

All the teeth which have been found, in juxtaposition with *Stagonolepis* remains, have short and obtusely pointed crowns, like the hinder teeth of existing Crocodiles. They sometimes show signs of being worn down by mutual attrition.

In the pectoral arch, the scapula resembles that of recent Crocodiles; but the coracoid is short and rounded, like that of *Belodon*, of the *Ornithoscelida* and of some Lizards (e.g., *Sphenodon*).

As in Crocodiles, there is an interclavicle; but, apparently, no clavicles existed.

The humerus is more lacertian than that of recent Crocodiles and resembles that of *Belodon*, in the expansion of its proximal end, and in the presence of a ridge, marked off by a groove, on the radial side of its distal end.

The ilium differs from that of Crocodiles in the large size of the ala, especially in front, and in the forward prolongation of its anterior dorsal angle; further, in the shape of the ventral margin of its acetabular portion, and in the absence of any notch or excavation of that margin.

The acetabular end of the ischium is like that of a Lizard and unlike that of a Crocodile; and the rest of the bone is much shorter dorso-ventrally and longer antero-posteriorly than in Crocodiles, in both which respects it closely resembles *Belodon*.

The distal end of the femur is narrower in proportion to its proximal end, and to the distal end of the humerus, than in existing Crocodiles; in which respect again, *Stagonolepis* resembles *Belodon*.

Among known forms of Reptiles, the nearest ally of *Stagonolepis* is undoubtedly the *Belodon* of the Upper Keuper of Wurtemberg, of which the remains of several species have been made known by H. Von Meyer ("Palæontographica," Bände VII., X., XIV., 1861-1865). Von Meyer describes and figures scutes, vertebræ of various regions (though not of the sacrum); and very perfect crania and teeth; the scapula, coracoid, and humerus; the ilium and the femur; and, when I was in Stuttgart, in 1873, Herr Kapff had the goodness to show me a pelvis, with the ischium in place.

An extensive comparison can therefore be instituted between *Belodon* and *Stagonolepis*; and it proves (as I have incidentally pointed out) that the two genera resembled one another in many respects, but nevertheless were separated by highly important differential characters.

That the skulls were exceedingly unlike is sufficiently obvious from the comparison of even such imperfect fragments of the cranium of *Stagonolepis* as have come to light, with the remarkably well-preserved skulls of *Belodon* which are now known. The teeth are widely different; and, as the complete dentition of *Belodon* is known, the difference between the two genera cannot be diminished by the discovery of the teeth of the anterior ends of the jaws in *Stagonolepis*, which may well have been more acuminated than the posterior teeth.

The dorsal scutes of *Belodon* are much more strongly carinated than those of *Stagonolepis*. Whether *Belodon* possessed ventral scutes or not, is not certainly known; but I find no scutes which can be certainly recognised as such among Von Mayer's numerous figures.

The *Crocodilia* are definable from all other *Reptilia*, recent and extinct, by the following osteological characters:—

The majority of the cervical and thoracic vertebræ have transverse processes which are divided into more or less distinct capitular and tubercular portions; and the proximal ends of the ribs which appertain to these vertebræ are divided into capitula and tubercula. The dorsal ends of the sub-vertebral caudal bones are not united. The quadrate bone is immoveably fixed to the sides of the skull. The pterygoid bones send forward processes which separate the palatines and reach the vomers. There is an interclavicle, but no clavicles. The ventral edge of the acetabular portion of the ilium is entire, or notched. The ischia are not greatly prolonged backwards, and the pubes are directed forwards and inwards. The femur has no prominent inner trochanter. The astragalus is not a depressed and concavo-convex bone with an ascending process. There are, at fewest, two rows of dermal scutes, one on each side of the middle line of the dorsal region of the body.

Stagonolepis and *Belodon* come within the order *Crocodilia*, as thus defined, and constitute the first of three sub-orders distinguishable on purely anatomical grounds.*

SUB-ORDER I. *Parasuchia.* — Neither the palatine nor the pterygoid bones develope osseous plates which prolong the nasal passages and give rise to secondary posterior nares. Consequently, the nasal chambers communicate with the mouth by apertures situated beneath the anterior part of the skull. The

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* "On *Stagonolepis Robertsoni* and on the Evolution of the Crocodilia." Quarterly Journal of the Geological Society, 1875.

Eustachian passages are not inclosed by bone (*Belodon*). The centra of the vertebræ are amphicœlous. The coracoid is short and rounded. The ala of the ilium is high, with a large and projecting anterior dorsal angle; and its acetabular margin is entire, the middle portion projecting beyond the anterior and posterior extremities of that margin. The ischium is short dorso-ventrally, elongated longitudinally; and its acetabular portion resembles that of a Lizard. The characters of the manus and pes are unknown.

There are two longitudinal series of articulated carinated dorsal scutes; and in *Stagonolepis*, but apparently not in *Belodon*, there is a ventral thoraco-abdominal shield, formed of not more than eight longitudinal series of articulated flat scutes, each of which consists of only one piece of bone.

Genera, *Stagonolepis* and *Belodon.*

SUB-ORDER II. *Mesosuchia.*—The palatine bones give off osseous plates, which shut off nasal passages from the mouth; secondary posterior nares, which are situated beneath the middle or hinder part of the skull, are thus produced. The pterygoid bones take no share in the formation of this passage. A middle Eustachian canal is included between the basi-occipital and the basi-sphenoid, but the lateral canals are represented only by grooves. The centra of the vertebræ are amphicœlous.

The coracoid is elongated. The ala of the ilium is lower than in the preceding, higher than in the following sub-order, and has, at most, only a slight prolongation of its antero-dorsal angle. The acetabular margin is nearly straight; and hardly, if at all, excavated. The ischium is more elongated dorso-ventrally, and shorter antero-posteriorly, than in the *Parasuchia.* Its acetabular margin is excavated by a notch, which marks off a stout pubic process, as in the next division. The manus and pes are constructed as in the next sub-order.*

There are two longitudinal series of dorsal scutes, more or fewer of which are carinated; and, in most of, if not in all, the members of this division, there is a ventral thoraco-abdominal shield composed of not more than eight longitudinal series of flat scutes, each consisting of a single piece of bone. (See Plates XI. and XII.)

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* The manus is usually imperfect in even the best preserved fossil *Crocodilia*, but D'Alton and Burmeister (" Der Fossile Gavial von Boll," 1854) have figured and given Fitzingers' description, with additions of their own, of a nearly complete manus of *Pelagosaurus Bollensis* (Upper Lias) in the Vienna Museum. In all essential respects, the structure is identical with that of the manus of the *Eusuchia*, even down to the absence of claws on the terminal phalanges of the fourth and fifth digits, and the relative brevity and thickness of the first metacarpal. The same authors have shown that the pes of this oldest known form of the *Mesosuchia*, no less closely resembled that of the *Eusuchia.* The Memoirs of MM. Des Longchamps, father and son, contain an admirable account of the organisation of the *Mesosuchia* at present known. See the " Prodrome des Téléosauriens du Calvados," in the " Notes paléontologiques," vol. i., by M. Eugène E. Deslongchamps, and the various memoirs of M. Eudes Deslongchamps, contained in the " Bulletin " and the " Mémoires" of the Société Linnéene de Normandie.

To this division belong the genera *Steneosaurus, Pelagosaurus, Teleosaurus, Teleidosaurus,* and *Metriorhynchus;* with, probably, *Goniopholis,* and *Pholidosaurus.*

SUB-ORDER III. *Eusuchia.*—Both the palatine and the pterygoid bones are produced into osseous plates, which prolong the nasal passages backwards, and give rise to secondary posterior nares situated beneath the hinder part of the skull. There is either a central Eustachian canal, with two lateral grooves; or, more usually, there are three canals, completely inclosed by bone. The centra of the vertebræ which succeed the atlas and axis are procœlous, except in the case of the sacral and the first caudal, which last is doubly convex. The coracoid is elongated. The ala of the ilium is so low, in front, as to be almost obsolete, and there is only a rudiment of an anterodorsal process. The acetabular margin has a well-marked notch. The ischium is elongated dorso-ventrally and short antero-posteriorly. The acetabular margin presents a deep excavation, in front of which is a strong process, with which the pubis is articulated.

The number of the digits is five in the fore foot, and four, with a rudimentary fifth, in the hind foot.

There are always more than two longitudinal series of carinated dorsal scutes, and always more than eight series of flat ventral scutes, when the latter are present. The ventral scutes are made up of two ossifications, united suturally. (See Plate XIII.)

It is obvious, from the mere statement of the characters of these three divisions, that the one which I have termed *Mesosuchia* is intermediate between the other two. It is further obvious that the *Parasuchia,* in those respects in which they differ from the *Mesosuchia,* approach the *Ornithoscelida* and the *Lacertilia,* especially such *Lacertilia* with amphicœlous vertebral centra as the existing *Sphenodon,* and the extinct *Hyperodapedon.* In fact, I know of no reptiles the skull and pectoral arch of which so nearly approach the structure found in *Belodon* and *Stagonolepis,* as they do in *Sphenodon.* (See Plate IX.)

On the other hand, the *Eusuchia* are those *Crocodilia* which depart most widely from the Lacertilian type and are the most completely specialised Crocodiles.

The differences between the *Mesosuchia* and the *Eusuchia* are of no great moment. The Messrs. Deslongchamps, in their "Prodrome des Téléosauriens du Calvados" ("Notes Paléontologiques, Vol. I. 1863–9") have shown that the secondary posterior nares of *Metriorhynchus,* which ranges from the Kelloway rock to the Kimmeridge clay, are situated further back than those of *Pelagosaurus,* which is confined to the Upper Lias. Let this process be carried a little further by the union of the pterygoids; let the posterior faces of the centra of the vertebræ become slightly convex, instead of being, as at present, slightly concave; and *Metriorhynchus* would afford a complete transition from the *Mesosuchia* to the *Eusuchia.*

The *Parasuchia*, in the position of the anterior nares; in the absence of secondary posterior nares, and of Eustachian canals inclosed by bone; in the rounded form of the coracoid; in the configuration of the ilium and the ischium; depart more widely from the *Mesosuchia* than the latter do from the *Eusuchia.*

From a purely morphological point of view then, the three subdivisions of the *Crocodilia* form a series, slightly interrupted between the *Mesosuchia* and the *Eusuchia,* but with a larger gap between the *Mesosuchia* and the *Parasuchia.* But, whatever the value of this break between the three terms of this series, this much is clear, that the modifications of structure needful to connect one with the other are of the simplest kind and are throughout of the same order. The kind of change which would convert a Parasuchian into a Mesosuchian, would, if continued, convert a Mesosuchian into an Eusuchian.

Hence, if there is any solid historical foundation for the doctrine of Evolution, the *Eusuchia* ought to have been developed from the *Mesosuchia,* and these from the *Parasuchia;* and if this process of evolution has taken place under such conditions that the skeletons of the *Crocodilia* which have existed during its occurrence have been preserved, geological evidence should prove that the *Parasuchia* have preceded the *Mesosuchia,* and that the *Eusuchia* have succeeded them in order of time.

Now this is exactly what the geological evidence does prove. It is established that these reptiles occur in the following stratigraphical order:—

1. The *Parasuchia,* in the - - *Trias* and perhaps earlier.
2. The *Mesosuchia,* in the Middle Mesozoic rocks from the *Upper Lias* to the *Wealden.*
3. The *Eusuchia,* in the later Mesozoic rocks and in the Tertiaries from the *Later Cretaceous* to the *Recent Epoch.*

In other words, the order of occurrence of the three divisions of the *Crocodilia* in time, coincides with the order in which they depart from the Lacertilian type, and put on special crocodilian characters; and thus, palæontological fact is in precise accordance with the needs of the theory of Evolution. The evidence in favour of the gradual development of existing from ancient *Crocodilia,* is in fact as cogent, though not so complete, as that by which the origin of the horse from a three-toed ancestor has been demonstrated.

The evolution of *Equus* from its anchitherioid ancestor appears to have nearly occupied the time represented by the Miocene deposits; while the evolution of the Eusuchian from the Parasuchian Crocodiles seems to have nearly coincided with the time represented by the deposit of the Jurassic formations.

It is very hard to estimate the amount of evolutionary work done in the change of one form into another, in widely different groups of the animal kingdom; but perhaps it will not be very far from the truth, to regard the one set of changes as about equal in value to the other.

Admitting the origin of the Horse by a process of gradual modification from some tridactyle or tetradactyle Eocene ungulate mammal, we cannot rest there. This Eocene form must have proceeded from some pentadactyle ungulate mammal, which must have existed before the Tertiary epoch, if it be true, as is commonly believed, that all the oldest known Eocene *Ungulata* possess not even a rudiment of the first digit.*

By a parity of reasoning, the ancestors of the *Parasuchia* must be sought in the older Triassic deposits, or in formations of still earlier date; and I think that it is not difficult to form a probable hypothesis as to the general characters of these ancestral forms, which in Haeckel's nomenclature would be termed *Prosuchia.*

The oldest *Crocodilia* known are, as I have shown, distinguished from the more recent forms by less divergence from such *Lacertilia* as *Sphenodon*, the type of the *Rhynchocephala* of Günther. We are therefore warranted in assuming that, in the immediate ancestors of the *Parasuchia*, the fundamental differences from the *Lacertilia* were still further lessened; that, in other words, the *Prosuchia* were intermediate between *Parasuchia* and *Lacertilia*, in the same way as the *Mesosuchia* are intermediate between *Parasuchia* and *Eusuchia.*

II.—A DENTIGEROUS BONE, INCERTÆ SEDIS.
(PLATE IV., FIG. 1.)

In my first paper on *Stagonolepis*, I have described " the impression of a fragment of what I conceive to be the lower jaw, exhibiting the remains of some eight or nine alveoli." After describing this impression I go on to observe—

> " There is no positive proof that this fragment of a jaw belonged to *Stagonolepis*; but as I have already stated, no vertebrate remains save those of this reptile have hitherto been found in the Findrassie quarry, whence this specimen was obtained, and the external characters and mode of implantation of the teeth are wholly unlike those of any of the large, probably piscine teeth (of *Dendrodus, e.g.*) which have been discovered in the neighbouring beds of the Old Red Sandstone . . . . If this jaw belonged to the same animal as that to which even the largest of the vertebræ which have been discovered belonged, the size of the teeth is remarkable, for the longest is considerably more than twice as long as the centrum of such a vertebra. On the other hand, it must be recollected that the teeth of the ancient *Teleosaurus* are extremely long in proportion to the jaw, and, in other respects, present resemblances to those contained in the fragment just described; while it is also possible that this fragment may have formed a part of an individual larger than any of those whose vertebræ have, as yet, come to light. As the evidence stands, at present, I see no reason to doubt that the jaw belonged to *Stagonolepis*."

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* According to the recent observations of Prof. Marsh, *Coryphodon* has five digits.

By degrees, however, the materials which have come into my hands proved that the latter conclusion was untenable ; and, two years ago,* I expressed the conviction that "the mandible with long curved teeth, which I supposed might belong to *Stagonolepis*, certainly appertains to some other animal."

I have since carefully re-examined this impression, the drawing of a cast of which is given in Plate IV., fig. 1.

The structure of which this impression alone exists, has evidently been a fragment of a crushed and mutilated bone which bore four teeth. The bone, opposite to that edge on which the teeth are set, is obviously imperfect, and its two ends are broken.

The total length of the fragment is 6·5 inches. The surface impressed by the bony matter is irregular, and has a peculiar vertical striation, as if the bone had possessed a coarsely fibrous structure. Moreover, the alveolar edge is very irregular.

The most anterior of the four teeth is situated at one extremity of the bone. Between the anterior contour of its fang and the posterior contour of the fourth tooth is a distance of four inches.

The first tooth is the slenderest. It has a slight curvature, the anterior face being more curved than the posterior. The second tooth is broader, straighter, more acutely pointed, and is the shortest of all. The third is the longest and stoutest as well as the most curved; and its impression, which is incomplete at the apex, projects 2·25 inches beyond the alveolar margin of the jaw. The base of the tooth is rather more than half an inch thick. The hindermost tooth is inclined backwards, and has evidently been much crushed before, or during, its enclosure in the sandstone matrix.

In my first paper, I have spoken of the alveoli of this fragment of a jaw; and no doubt there are appearances which lend themselves to the view that the teeth were lodged in alveoli, and that empty alveoli existed in the space between the third and fourth, and behind the latter tooth ; and, possibly, between the second and third teeth. But it is impossible to make sure of their existence, and I would rather leave that point open.

The impression of each tooth is marked by raised longitudinal striæ, which are obviously casts of grooves on the face of the tooth. They are irregular at the base, nearly parallel in the middle, and die out towards the apex of the tooth, which is nearly smooth.

The bases of the teeth do not expand where they join the bony substance of the jaw, and the manner in which they have been crushed strongly suggests the existence of a large pulp cavity. On the other hand, it may be that the longitudinal striæ indicate true longitudinal grooves of the face of the tooth, and not fractures ; and that the crushing of the bases of the teeth, like the splintery aspect of the substance of the bone, may be due to pressure, subsequent to fossilization.

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* "On *Stagonolepis Robertsoni*, and on the Evolution of the Crocodilia."—Quarterly Journal of the Geological Society, vol. xxxi., p. 424.

Nothing is to be seen of any impressions of small teeth, between the large ones.

Looking at the texture of the bone and the longitudinal groovings of the teeth (if the ridges really express natural grooves), one would be inclined to refer this fossil either to the Labyrinthodonts, or to such a fish as *Rhizodus.*

On the other hand, the absence of small teeth, and of any clear indications of ankylosis of the teeth to the jaw, no less than the presence of large pulp cavities (if the mode in which the teeth are fractured may safely be taken as indications of these), point to affinities with such reptiles as *Megalosaurus.*

The impression of the bony substance of this jaw alone is sufficient to exclude any comparison with *Stagonolepis,* the texture of the osseous matter of the mandibles and maxillæ in that reptile being remarkably close and dense.

As it may be convenient that the animal to which this jaw belonged should have a name, I will call it *Dasygnathus longidens.*

III.—THE ICHNITES OF THE CUMMINGSTONE SANDSTONES.

In the year 1851, Captain Lambert Brickenden gave the following account* of a series of footmarks which he had discovered in a quarry of the sandstones of Cummingstone, near Elgin.

> "The slab exhibits on the surface, in a very striking manner, thirty-four footprints of a quadruped, traced in an uninterrupted succession across the stone. The impressions of the right feet alternate with those of the left, from which they are separated laterally by an interval of 3 inches, the length of each stride or pace being about 4 inches. The imprints of the fore and those of the hind feet are nearly in contact, and bear a precisely similar relation throughout, the size of the footmarks in the former in proportion to the latter is as three to four, the hinder being about 1 inch in diameter.
>
> "The imprints are slight cavities, and are all characterised by the same rounded and blunt appearance, apparently indicating that the articulations of the feet were closely connected, although, from the crystalline and arenaceous surface of the stone, the form and number of the joints of the toes cannot be positively determined.
>
> "A slight trailing mark is observable between the footmarks. In some of the marks it appears that the foot, in pressing in the originally yielding sand, had slightly raised the surface of the heel, but this is scarcely perceptible in the drawing."

The track is figured of one-sixth of the size of nature in the plate which accompanies the paper.

Various slabs of sandstone from the Cummingstone quarries, exhibiting footmarks, were sent to me in 1858, and I have figured and described some of these imprints in my first Memoir on *Stagonolepis.* No new materials of importance have since come into my hands, but some additional experience in dealing with tracks has led me to doubt whether my interpretation of the impressions in question was in all respects correct. Those who have studied such markings most carefully will be the readiest to acknowledge the extreme difficulty of arriving at a definite conclusion as to the cause of appearances, which vary, not only according to the softness or hardness of the sand on which the animal walked, but exhibit the most astonishing differences when lighted from different sides.

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* Quarterly Journal of the Geological Society, 1852, vol. viii., p. 98.

The most complete impressions I have seen (Plate XIV.) form part of a series of three pairs of right, and two pairs of left footprints. The former measure about 2 feet 6 inches from the hinder end of the hind foot to the front end of the fore foot of the same side. The distance between the median edges of the two sets of footprints nowhere exceeds 4 inches. The stride, or distance between corresponding points of successive impressions of the same foot, is, as nearly as may be, 12 inches; and the long axes of the pedal impressions are nearly parallel with the line of march, the marks of the digits being only very slightly convex inwards.

The impressions of the two feet which constitute a pair of the same side, are close together, the anterior extremity of the posterior impression, just reaching the posterior margin of the anterior impression. The centre of the posterior impression is a little external to that of the anterior impression, so that the outer margin of the former projects beyond that of the latter. There is no sign of any trail between the right and left set of footmarks.

These characters of the tracks, taken together with the dimensions of the footmarks, appear to me to indicate that the animal which made them possessed limbs, which were long relatively to the transverse diameter of its body, and which moved in a plane nearly parallel with the median longitudinal plane of the body. The footprints which are best defined are the hinder and the middle pair on the right side; but the hinder pair have been made upon a part of the sand which was firm, while the middle pair have fallen upon a soft wet place, whence the feet have sunk deeper and a thick ridge of sand has been thrown up behind each. Hence the two pairs of impressions must be taken together in judging of the form of the foot which gave rise to them. The posterior pair furnish the best guide to the actual size of the feet, while the anterior pair give the better insight into some points of their structure.

The posterior pair of impressions are represented in Plate XV., fig. 5.

The forefoot presents a convex posterior margin, in front of which is a smooth space, indicating a half-moon shaped pad in the sole of the foot. In front of this, are seen three sharp and well-defined longitudinal groove-like depressions, as if of as many digits sheathed in claws. The two longitndinal depressions on the inner side of the foot are of nearly equal length and strength; while the outer is shorter, not so well marked, and more distant from either of the two long grooves, than they are from one another. The impression of the sole projects for some little distance on the outer side, beyond the short groove; as it does on the inner side, beyond the innermost of the long grooves.

On comparing this with the front foot-mark of the middle pair (Plate XIV., *B*), which was certainly made by the same foot, the difference between the two appears at first sight very considerable, and especially does the impression (*B*) seem to be that of a much broader foot. Nevertheless, if the two longer longitudinal grooves in the imprint last described be compared with the strong longitudinal grooves in that represented in Plate XV., fig. 1., they will be found to correspond very closely in size, form, and distance from one another, while a fainter and shorter longitudinal marking lies on the outer side of the foot, at the same greater interval from the two long impressions, as in the foregoing case. Moreover, there is a similar projection of the sole on the outer side beyond the short impressions. In addition, the middle foot-mark (*B*) shows another longitudinal marking, faint in front, but becoming deeper behind, which lies parallel with the inner of the two longest longitudinal grooves already mentioned. Beyond this, the impression of the sole extends a little way, and from its inner end a still more faint longitudinal mark extends forwards, and ends at about the level of the hinder extremities of the two longest and strongest longitudinal grooves. A well-marked transverse groove, deeper and wider at its inner than at its outer end, and hence, when lighted obliquely, having the aspect of a comma, marks the place at which the shelving posterior part of the impression of the sole ends. In some lights, the form of the impressed surface in this region is such as to give rise to the appearance of an inwardly directed thumblike digit, such as I have mentioned in my first paper, but I am now convinced that the facts do not warrant this interpretation.

The interspaces between the longitudinal depressions are convex and smooth, as if they had been moulded by a web, and a tolerably well-defined line, concave forwards, which lies between the innermost and the second, longitudinal depression, marks, I conceive, the anterior boundary of the web in this region.

It can hardly be doubted, I think, that the longitudinal depressions indicate as many digits. In this case, the animal must have possessed a broad forefoot, provided with five, probably clawed, toes, of which the three middle were much longer than the inner and outer; and these digits were, in all probability, connected by webs.

The greatest length of these footmarks, judging from the posterior one, in which the hinder margin is best defined, is 3·5 inches, while the width can hardly have been less than 3 inches, and may have exceeded this dimension.

The impression of the hinder foot, in its general character, is very similar to that of the forefoot, but the toes are shorter relatively to the sole. The marks of four digits are plainly discernible, and there are indications of interdigital membranes between them. I am not quite certain as to the existence of a fifth toe. I do not think that the transverse diameter can have exceeded 2·5 inches, nor the antero-posterior diameter have quite reached that length.

The excess of size of the anterior over the posterior footmarks is a very striking peculiarity of these tracks. I do not think there can be any doubt that the posterior footmarks belong to the hinder feet. Not only are they regularly posterior in position; but, in the middle pair of the right side, figured in Plate XIV., the straight markings which indicate the digits of the hinder impression encroach upon the disturbed sand behind the anterior footmark, in such a way as to show that they must have been made after the anterior impression was formed; or, in other words, by a foot which was put down after the forefoot had been taken away.

On one side of the slab, near the middle pair of footprints of the track just described, are two confused marks of similar feet, but fully twice as large (Plate XV., fig. 6).

Plate XVI. represents, on a reduced scale, the surface of another slab of sandstone from Cummingstone, about 3 feet long by 20 inches wide, covered with tracks of quadrupedal animals, which all appear to have been going the same way, as if a herd were travelling together.

The footprints (some of which exceed 1·5 in. in transverse diameter) alternate, and those of the fore and hind feet are close together; the right and left series being separated by an interval which is narrow in proportion to the breadth of the foot, as in the preceding tracks. Moreover, they resemble the larger footprints in their width relatively to their length, and in the rounded posterior contours of the impressions. They differ in the relatively smaller size of the anterior footprints.

In some of these tracks the anterior impressions appear to be smaller than the posterior (Plate XV., figs. 1 and 4); and in some, it looks as if the fore foot had only three digits, while the hind foot had four. (Plate XV., fig. 4.)

The two sets of footsteps here described agree with those discovered by Captain Brickenden, in their rounded posterior contours, in the alternation of the pairs of opposite sides, and in the direction of the long axes of the feet parallel with the line of march. They differ, not merely in absolute size, but in the distance between the two series of tracks made by the same animal, relatively to the size of the footprints; and, still more remarkably, in the relative sizes of the fore and hind footprints, the first-described set alone having the anterior footprints the larger.

On comparing these ichnites with others, the Triassic *Cheirotherium* is obviously excluded, as are the singular footprints from Shrewley Common described by Murchison and

Strickland;[*] nor, among the numerous figures and descriptions[†] of footprints which I have examined, do I find any which closely approach these, except some of those from Dumfriesshire, which have been the subject of Memoirs by Dr. Duncan,[‡] Sir W. Jardine,[§] and Mr. Patrick Dudgeon.[‖]

The impressions described by Dr. Duncan have the general facies of those here described, but the impressions of the fore and hind feet are said to be nearly equal. In Sir William Jardine's work, the figures of footprints which come nearest to the first described set from Cummingstone, are to be found in Plate VI. and Plate XI. (*Chelichnus ambiguus*), and Plate XIII. (*Batrachichnus Lyellii*). But, in both these, the anterior footmarks are the smaller.

Without wishing to express any opinion as to the actual affinities of the makers of the various kinds of footprints, I think it will be convenient to consider the first series of footprints which are here described as a modification of Sir W. Jardine's *Chelichnus*, and to name them *Chelichnus megacheirus.* The second series of tracks are not sufficiently well marked to justify the application of any specific name to them.

The questions of the nature of the animals which gave rise to *Chelichnus* tracks, and of the relations of such animals with *Stagonolepis,* appear to me, at present, hardly to admit of profitable discussion, except so far as certain negative conclusions may be pretty safely reached.

Footprints, similar to those which I have named *Chelichnus megacheirus,* could not have been made by any existing species of Crocodile, nor by any of the *Mesosuchia,* if we may draw a general conclusion respecting the structure of the feet of these reptiles as a whole, from those in which the structure of the feet is accurately known.

In all recent Crocodiles, the pentadactyle fore foot is considerably smaller than the tetradactyle hind foot. In the fore foot, the second and third digits are nearly equal in length, and are directed forwards, in the standing or walking attitude; the first digit is much shorter, and turns a little inwards; the fourth, also much shorter than the third, is inclined obliquely outwards, while the still shorter and weaker fifth digit often stands at a right angle to the long axis of the foot, or may even be inclined backwards.

In the hind foot, the second and third digits are longest and equal, as in the fore foot. The hallux and the fourth digit are also of nearly the same length and much shorter than the middle toe. The hallux lies nearly parallel with the second digit, but the fourth toe diverges outwards to a certain extent.

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[*] "On the Upper Formations of the New Red Sandstone System."—Transactions of the Geological Society of London, Se. II., vol. v., 1857.

[†] In Hitchcock's "Ichnology of New England," and its supplemental volume, for example, I find no track but "Shepardia" in Plate XXIV., fig. 2, of the first-mentioned volume, which, even remotely, approaches *Chelichnus.*

[‡] "An Account of the Tracks and Footmarks of Animals found impressed in Sandstone in the Quarry of Corncockle Mine in Dumfriesshire."—Transactions of the Royal Society of Edinburgh, vol. xi., 1828.

[§] "The Ichnology of Annandale," 1853.

[‖] Proceedings of the Royal Society of Edinburgh, vol. ix., p. 154, 1876.

It is obvious that feet such as those just described could not, by any possibility, give rise to such impressions as those of *Chelichnus megacheirus*.

At the same time, the large size of the distal end of the humerus relatively to that of the femur in *Stagonolepis*, and the great thickness of the metatarsal or metacarpal bone (Plate VIII., fig. 5), suggest that the *Parasuchia* may have had larger fore feet and broader metacarpal and metatarsal regions than the *Mesosuchia* and *Eusuchia*; while it is, at any rate, not improbable, that, to the many approximations of the *Parasuchia* to the *Lacertilia*, there may have been added a complete fifth toe on the hind foot.

Leaving aside the Geckos and the Chamæleons, which hardly need to be considered in the present comparison, the fore and hind feet of the Lizards present a very general and characteristic uniformity. Both are pentadactyle, and the fore foot is smaller, usually much smaller, than the hind foot.

In the fore foot, the fourth digit is the longest and may be directed almost or quite forwards, *i.e.* in the line of march. The fifth digit is much shorter, and the other digits gradually decrease in length, from the third to the first. Thus, the imprints of such a foot will contain the marks of a long digit, on the inner side of which diverge three shorter digits, and on the outer side, one.

In the hind foot, the fourth digit is also longest, but it is directed obliquely outwards, and the first three digits, successively shorter from the third to the hallux, lie on its inner side, the hallux being nearly parallel with the line of march. The fifth toe is well separated from the fourth, on the outer side of the foot, and projects outwards at right angles to the long axis of the foot, or even more or less backwards.

If the ancient Lizards of the Trias possessed feet similiar to those of modern Lizards, and all that is known of *Telerpeton* and *Hyperodapedon* leads to the conclusion that they did, it is clear that they can have had nothing to do with the production of *Chelichnus* tracks.

Dr. Buckland suggested that the Dumfries footmarks were made by Chelonians, and this conclusion has been accepted by Professor Owen, who went so far as to name the particular tortoise which left the tracks, *Testudo Duncani.**

In the Tortoises which I have had an opportunity of examining, the disposition of the digits of the fore and hind feet, and the marks which they leave when the animal walks, are very characteristic. In the fore foot, the majority of the five toes are turned inwards, in such a manner that their apices describe a curve, the convexity of which is turned inwards. In the hind foot, on the contrary, the toes are turned outwards, and their apices occupy a curve the convexity of which is turned outwards and forwards. Thus, for the feet of the same side, the curves are nearly at right angles to one another.

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* "Report on British Fossil Reptiles." Report of the eleventh meeting of the British Association for the Advancement of Science, p. 190.

The fore and hind feet have nearly the same dimensions in the Tortoises. The nail marks on the imprints of the feet are short relatively to the impressions of the broad palmar or plantar pad. The hind foot generally drags, scraping a long broad mark as it is thrown forwards. In walking, it is usually set down in the imprint of the fore foot, which it more or less obliterates. Sometimes, however, the hind foot oversteps the impression of the fore foot of the same side, so that the hind footprint may lie in front of the fore footprint.

In their brevity, breadth, and short claw marks, the imprints of tortoises' feet are somewhat like *Chelichnus*; but, in the latter, the characteristic inward twist of the anterior digits and outward twist of the posterior digits is wanting. At the same time, the breadth of the track, or the interspace between the right and left foot prints, made by the same animal, in the Chelonians, is, in proportion to the size of the feet and the length of the stride, vastly greater than in *Chelichnus*.

In fact, there is really no ground for ascribing these tracks to Chelonians.

Living *Amphibia* never possess more than four complete toes on the fore feet, though most have five on the hind foot. The hind foot is usually the larger, though there is a great variation in this respect; and in *Urodela* (*e.g.*, *Menopoma*,) there may be little difference between the two.

It is a very general rule that, as in Lizards, the fourth toe (apparent third in the manus) is the longest, in both the fore and the hind limbs. And the fourth toe is that which generally lies parallel with the direction of the line of march. This is particularly obvious in the pes of the *Anura*, where this toe, instead of being strongly bent outwards, as in the Lizards, is straight, or even slightly bent inwards. In the hind foot, the hallux is short, and is directed transversely inwards or even a little backwards. The imprint of this foot, therefore, is the reverse of that of the Lizards, inasmuch as the transversely directed toe is on the inner side of the foot, and not on its outer side.

I know of no Amphibian with feet such as could produce *Chelichnus* tracks.

The general result of these considerations is to lead me to doubt whether the *Chelichnus* tracks can, at present, be safely referred to any known form of Reptile or Amphibian. The tenor of the evidence appears to be strongly against ascribing them either to *Amphibia*, *Lacertilia*, or *Chelonia*; but I think it must be allowed that they might have been produced by pentadactyle *Parasuchia* or *Ornithoscelida*.

I am indebted to the Rev. Dr. Gordon for the following note upon the geological structure of the Elgin district, and for the valuable map showing the localities in which reptilian remains and tracks occur, which accompanies this memoir.

T. H. H.

NOTE UPON THE GEOLOGICAL STRUCTURE OF THE ELGIN DISTRICT, BY THE REV. GEORGE GORDON, D.D.

THE lower or northern part of Elginshire, in which reptiliferous beds appear, has been visited and described by several geologists. The different papers, containing the result of their observations, are referred to by Sir Roderick Murchison in the Quarterly Journal of the Geological Society for August 1859, and by J. W. Judd, Esq., in the same Journal for May 1873.

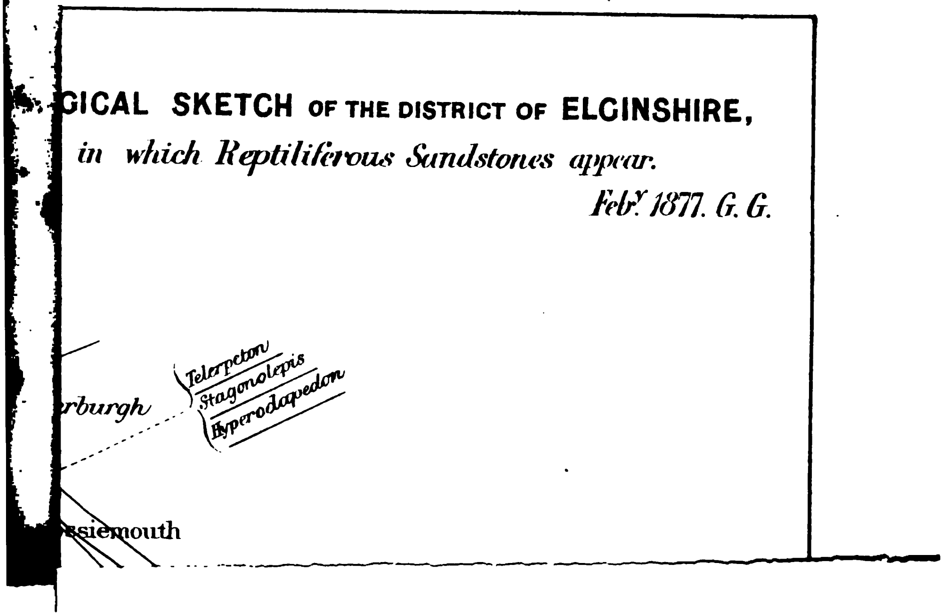
For some time after the discovery of the *Telerpeton*, at Spynie, and up to the finding of a slab at Findrassie, which clearly proved the reptilian character of *Stagonolepis*, these beds, conformably following, and lithologically resembling the holoptychian, or undoubted "Old Red" strata, were supposed to belong to the same geological epoch. The next discovery, of the *Hyperodapedon*, then induced most geologists to regard them as of a later, or the Triassic age.

Although the quarrymen are generally alive to any organism that may turn up in their labours, yet it is singular that no other remains (animal or vegetable) have as yet been detected in these reptiliferous beds; bones, scutes, and footprints forming the whole of their vestiges. There are concretions of pyrites, probably coprolites, but no organic structure has been seen in them.

The accompanying sketch is intended to mark the different localities where the various rocks come to the surface, and to point out their dip, where it has been ascertained. No outline, to show their probable range, has been attempted.

The district is so covered by drift, that no junction of the holoptychian and reptiliferous strata has been laid bare.

It is supposed that the plain (of drift) on which Elgin stands, and particularly to the east of that town, is underlaid by the cherty or concretionary rock, and it again by the reptiliferous sandstones; but no vestige of reptilian remains has been found within this area.



GICAL SKETCH OF THE DISTRICT OF ELGINSHIRE,
in which Reptiliferous Sandstones appear.
Febʸ 1871. G. G.

DESCRIPTION OF THE PLATES.

PLATE I.

Fig. 1. *Stagonolepis.*—The original specimen, exhibiting impressions of the ventral scutes described and figured by Agassiz: "Poissons fossiles du vieux Grès rouge," p. 139, and Plate XXXI. (Elgin Museum, No. 27.)

Fig. 1*a*. *Stagonolepis.*—A cast taken from the preceding specimen, exhibiting the characters of the pitted ornamentation of the original scutes.

Fig. 2. *Stagonolepis.*—Two ventral scutes. (Dr. Taylor's Collection.)

Fig. 3. Ventral scutes of a species of *Jacare*, showing the manner in which the successive zones overlap; the sutural union of the scutes of the same zone; that of the anterior and posterior portions of each scute; and the pitted sculpture of the exposed surfaces of the scutes.

Fig. 4. *Stagonolepis.*—Fragment of the upper and lower jaws, with teeth. (Museum of Practical Geology.)

Fig. 4*a*. The extremity of the mandible of the same specimen, showing a tooth in its alveolus. × 2.

Fig. 5. *Stagonolepis.*—Cast of an impression of the anterior end of a thoracic vertebra. (Elgin Museum, No. 36.)

Figs. 6, 6*a*, 6*b*. *Stagonolepis.*—End, lateral, and ventral views of the cast of an impression of a cervical vertebra. (Elgin Museum.)

Fig. 7. *Stagonolepis.*—End view of the cast of an impression of a posterior cervical vertebra. (Elgin Museum, No. 50.)

PLATE II.

Fig. 1. *Stagonolepis.*—Cast of an impression of a dorsal scute. (Elgin Museum, No. 26.)

Figs. 2, 5, 6. *Stagonolepis*—Cast of impressions of dorsal scutes on the same block of sandstone. (Elgin Museum, No. 2.)

Fig. 3. *Stagonolepis.*—The outer surface of a dorsal scute the bony matter of which is tolerably well preserved.

Fig. 4. *Stagonolepis.*—Cast of an impression of a dorsal scute. (Elgin Museum, No. 10.)

Fig. 7. *Stagonolepis.*—The impression of a ventral scute.

Figs. 8 and 9. *Stagonolepis.*—Impressions of the inner surface of a dorsal scute.

Fig. 10. *Stagonolepis.*—Inner face of a dorsal scute (from Lossiemouth), part of which has been cleared away to show the impression left by the outer surface.

Fig. 10*a*. A transverse section showing the angulation of this scute.

Fig. 10*b*. A sectional view of the outer extremity of the same scute.

PLATE III.

Stagonolepis.—Fig. 1, ventral; Fig. 1*a*, dorsal; Fig. 1*b*, lateral aspect of the natural cast of a portion of the caudal region (in the Collection of J. Powrie, Esq.), two thirds of the natural size. Fig. 1*c*, interior view of the longer half; and Fig. 2 the cast of the interior of the shorter half of the same fossil: of the natural size.

PLATE IV.

Fig. 1. *Dasygnathus longidens.*—Cast of the impression of the dentigerous bone. (Elgin Museum, No. 1.)

Fig. 2. *Stagonolepis.*—The cast of the impression of a caudal vertebra. (Elgin Museum, No. 4.)

Fig. 3. *Stagonolepis.*—The cast of the ventral aspect of the caudal fragment. (Plate III. fig. 1.)

Fig. 4. *Stagonolepis.*—The cast of the interior of the longer half of the same. (Plate III. fig. 1*c*.)

PLATE V.

Figs. 1—1*e*. *Stagonolepis.*—The fragment of the skull with teeth described at pp. 23, 24. (Elgin Museum, No. 38.)

Figs 2—2*b*. *Stagonolepis.*—Anterior, lateral, and ventral views of the cast of an impression of a vertebra from the fore part of the thoracic region. (Elgin Museum, No. 22.)

Fig. 3. *Stagonolepis.*—Cast of an impression of the anterior end of a thoracic vertebra. (Elgin Museum, No. 11.)

Fig. 4. *Stagonolepis.*—Impression of the posterior end of the first sacral vertebra. (Elgin Museum, No. 47.)

Fig. 4*a*. Cast taken from the same specimen.

PLATE VI.

Fig. 1. *Stagonolepis.*—The inner face of an ilium; and

Fig. 2. A femur. Fig. 2*a*, contour of the exposed face of this bone. These two bones are represented of three fourths the size of nature, and nearly in the relative position which they occupy on a block of Lossiemouth sandstone. (Elgin Museum, No. 46.)

Figs. 3—3*c*. *Stagonolepis.*—The imperfect symphysial end of a mandible with teeth. (Museum of Practical Geology.)

PLATE VII.

Fig. 1. *Stagonolepis.*—The cast of an impression of a caudal vertebra.

Fig. 2. *Stagonolepis.*—The impression of the posterior face of a thoracic vertebra. (Elgin Museum, No. 12.)

Fig. 3. *Stagonolepis.*—The impression of the arch, and of the commencement of the spine, of a thoracic vertebra. (Elgin Museum, No. 49.)

Figs. 4, 4*a.* *Stagonolepis* (?)—Cast of an impression of a posterior caudal vertebra. (Elgin Museum, No. 17.)

Fig. 5. *Stagonolepis.*—A rib from Lossiemouth, one half natural size.

Fig. 6. *Stagonolepis.*—A cast of the impression of the vertebral end of a rib. (Elgin Museum, No. 26.)

Fig. 7. *Stagonolepis.*—Humerus. (Elgin Museum, No. 26.)

Fig. 8. *Stagonolepis.*—Femur. From Lossiemouth, one half natural size

Fig. 9. *Stagonolepis.*—Radius or fibula. From Lossiemouth. (Elgin Museum, No. 33.)

PLATE VIII.

Fig. 1. *Stagonolepis.*—Coracoid. From Lossiemouth. (Elgin Museum, No. 37.)

Fig. 2. *Stagonolepis.*—Pubis. From Lossiemouth. (Elgin Museum, No. 39.)

Figs. 3, 3*a.* *Stagonolepis.*—Cast of the impression of the inner face and posterior edge of a scapula. (Elgin Museum, No. 20.)

Fig. 4. *Stagonolepis.*—Cast of the impression of a radius or fibula. (Elgin Museum, No. 26.)

Fig. 5. *Stagonolepis.*—Cast of the impression of a metatarsal or metacarpal bone. (Elgin Museum, No. 48.)

Figs. 6, 6*a.* *Stagonolepis.*—Cast of the impression of a metatarsal (?) bone. (Elgin Museum, No. 23.)

Figs. 7, 7*a.* Cast of an impression of an anterior caudal vertebra. (Elgin Museum, No. 18.)

PLATE IX.

Fig. 1. *Stagonolepis.*—The sandstone core; and Fig. 1*a*, the cavity which receives the opposite face of the core to that shown in the figure, of the specimen containing the fragment of the skull described at p. 19. (Museum of Practical Geology.)

Figs. 2, 2*a.* *Stagonolepis.*—Diagrammatic restorations of the palatal and lateral aspects of this fragment of the skull.

Fig. 3. *Stagonolepis.*—A portion of a maxilla with teeth. (Museum of Practical Geology.)

Figs. 4, 4*a.* *Stagonolepis.*—One of the maxillary teeth separately, of the natural size and magnified four times.

Fig. 5. Palatal view of the skull of *Gavialis Gangeticus.* (After D'Alton and Burmeister, *l.c.*)

Fig. 6. Palatal view of the skull of *Belodon.* (After Von Meyer, *l.c.*)

Fig. 7. Palatal view of the skull of *Sphenodon.* (After Günther. Philosophical Transactions of the Royal Society, vol. 157, pl. XXVI., fig. 2.)

In Figures 5, 6, and 7; *vo.*, vomer; *pt.*, palatine; *pt.*, pterygoid; *pn.*, primitive, and *s.p.n.*, secondary posterior nares.

PLATE X.

(All the figures in this plate are taken from casts of impressions of bones of *Stagonolepis* from Lossiemouth, and are in the Museum of Practical Geology. Figs. 2 and 9 are of the natural size, the rest are reduced to half of the size of nature.)

Figs. 1, 1*a*. Lateral and posterior views of the ankylosed scapula and coracoid.

Figs. 2, 2*a*. Front and side views of the interclavicle.

Figs. 3 and 4. Ilia.

Figs. 5 and 5*a*. Lateral and anterior views of an ischium.

Fig. 6. The proximal end of a humerus.

Fig. 7. An incomplete humerus.

Fig. 8. A tibia (?)

Fig. 9. A metatarsal or metacarpal bone.

Fig. 10. A restoration of the posterior lumbar, the sacral, and the anterior caudal vertebræ from the specimen described at p. 17.

PLATES XI. AND XII.

In these plates I have given, for comparison with *Stagonolepis*, figures of the dermal armour, of the skull, and of some other parts of the skeleton of one of the oldest known *Mesosuchia*, the *Crocodilus temporalis* of De Blainville, *Teleosaurus temporalis* of M. Eudes Deslongchamps. It has been identified with the *Pelagosaurus typus* of Bronn by M. Eugene E. Deslongchamps.*

Teleosaurus temporalis appears to have been a small animal, the largest known specimens hardly exceeding three feet in length. The species is confined to the Upper Lias.

The specimens represented in the Plates, formed part of the Tesson Collection, and are now in the British Museum. They have already been figured and described by M. Eudes Deslongchamps in his remarkable monograph† on the Teleosauria of the Jurassic epoch, which is supplemented in the "Notes Paléontologiques" of his son.

In his preliminary observations, M. Eudes Deslongchamps declares that his wish is far less to define species zoologically than to determine the anatomical relations of the *Teleosauria* with their nearest living allies, and he has admirably carried out his intention. Favoured with abundant materials, in an excellent state of preservation, he has compared the skeletons of the ancient reptiles, bone by bone, with their living analogues, and has traced out their resemblances and differences with a minuteness of detail which is but rarely practicable in palæontological inquiries.

The chief subject of M. Eudes Deslongchamps investigations is the species of which parts are here figured.

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* "Notes Paléontologiques," vol. i., 1869.

† "Mémoires sur les Téléosauriens de l'Époque Jurassique du Département du Calvados." "Mémoires de la Société Linnéenne de Normandie," vol. xiii., 1864.

M. Deslongchamps states that he found "en place et en rapport" (*l.c.* p. 65) the dorsal and ventral scutes represented in Plates XI. and XII., and he has described the manner in which the scutes have been adjusted into their present position. The scutes which are absent are indicated by outlines, in the construction of which M. Deslongchamps followed the analogy of the ventral armour of *Teleosaurus cadomensis*, with which he was already acquainted.

M. Deslongchamps, writing in 1856 (*l.c.* p. 63) appears to have learned that the Caimans and Jacares have ventral scutes from an article by the late Dr. J. E. Gray, published in the Annals and Magazines of Natural History for November 1862, and he says that the fact is not mentioned in any earlier work known to him. He appears to have overlooked the monograph of D'Alton and Burmeister, "Der fossile Gavial von Boll" (1854), to which I have referred in my first Memoir on *Stagonolepis*, no less than that essay itself, and another "On the specific and generic characters of recent Crocodilia," published in the "Proceedings of the Linnean Society" for 1859. The characters of the dermal armour of recent and extinct *Crocodilia* are fully discussed in these memoirs, with which Dr. J. E. Gray was perfectly well acquainted. D'Alton and Burmeister describe the ventral armour of a recent Crocodile (apparently a *Jacare*) with great accuracy, but they imagined that all recent Crocodilia possess a similar armour.

PLATE XI.

Figs. 1, 1*a*, 1*b*. *Teleosaurus temporalis.*—Dorsal, ventral, and lateral views of the skull.

Fig. 2. *Teleosaurus temporalis.*—The ventral armour, consisting of flat, articulated scutes, the surfaces of which present indistinctly radiating pits.

PLATE XII.

Fig. 1. *Teleosaurus temporalis.*—The thoraco-lumbar and anterior sacral dorsal scutes, with ribs.

Fig. 1*a*. The opposite face of the same specimen, exhibiting the vertebræ and ribs.

Fig. 1*b*. Ventral aspect of the sacral vertebræ, with one ilium in place, of the same specimen.

Fig. 1*c*. The posterior sacral and anterior caudal dorsal scutes of the same specimen.

Fig. 1*d*. Lateral view of the ilium.

PLATE XIII.

Figs. 1, 1*a*, 1*b*. *Caiman palpebrosus.*—Dorsal, ventral, and lateral views of the dermal armour of the neck, trunk, and anterior part of the tail.

Figs. 1*c*, 1*d*. The dermal armour of the antebrachium and of the crus.

Fig. 1*e*. A dorsal scute enlarged, showing its ridge and sculpture.

Fig. 1*f*. A ventral scute enlarged, showing the articular facet, the suture between the anterior and the posterior portions, and the radiating grooves of the surface.

PLATE XIV.

The footmarks from Cummingstone, described at p. 46.

PLATE XV.

Figs. 1, 2, 3, 4. Footprints on the slab represented and similarly numbered in Plate XVI.; of the size of nature.

Fig. 5. Footmarks from Cummingstone from the same series as those represented in Plate XIV.

Fig. 6. A footmark from the same slab as the foregoing, made by a much larger animal.

PLATE XVI.

The slab of sandstone from Cummingstone exhibiting many tracks, described at p. 48. One fourth the size of nature.

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MEMOIRS OF THE GEOLOGICAL SURVEY.

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